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CONTRIBUTION OF THE ETHANOL INDUSTRY TO THE ECONOMY OF THE UNITED STATES

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The ethanol industry faced several major challenges in 2012. First, a weak economy and high oil prices resulted in a decline in motor gasoline demand and, by extension, lower ethanol demand; the ethanol industry ran up against the E10 blend wall; and the industry was faced with soaring feedstock prices. Early-season expectations for a record corn crop and reasonable feedstock prices were dashed by the most severe drought in decades that resulted in a 16 percent decline in yields. Despite the largest number of corn acres planted in more than 50 years, corn production for the 2012-13 marketing year fell nearly 13 percent resulting in record corn prices. Reflecting these challenges, total ethanol production nationally fell nearly 5 percent to an estimated 13.3 billion gallons.[1]

According to the Renewable Fuels Association, at year's end the ethanol industry comprised approximately 211 plants in 28 states with nameplate capacity of 14.7 billion gallons and operating at an annualized rate of 13.1 billion gallons. At year's end about 158 million gallons of new capacity were under construction. However, reflecting declining profitability, the number of operating plants and operating rates fell, particularly during the second half of the year. This study estimates the contribution of the ethanol

[1] The 13.3 billion gallon estimate is based on annualized year-to-date ethanol production reported by the Energy Information Administration.

industry to the American economy in 2012 in terms of the employment, income, and Gross Domestic Product (GDP) directly and indirectly supported by the industry.

Expenditures by the Ethanol Industry in 2012

Ethanol producers are part of a manufacturing sector that adds substantial value to agricultural commodities produced in the United States and makes a significant contribution to the American economy.

Expenditures by the ethanol industry for raw materials, other goods, and services represent the purchase of output of other industries. The spending for these purchases circulates through the local and national economy, generating additional value-added output, household income, and employment in all sectors of the economy.[2] Ethanol industry expenditures can be broken into three major categories: construction of new production facilities, ongoing production operations and research and development.

1. Construction

   Relatively little new construction was initiated during 2012. As a consequence we did not include capital spending associated with the construction of new ethanol plants in the estimation of industry economic contribution in 2012.

2. Ongoing production operations

   The industry spent nearly $40 billion on raw materials, other inputs, and goods and services to produce 13.3 billion gallons of ethanol during 2012. Production costs were based on a model of dry mill ethanol production maintained by the author. These estimates are consistent with generic dry mill ethanol costs such as those published by Iowa State University.[3] Table 1 details the expenditures by the ethanol industry in 2012.

[2] Expenditures for feedstock and energy were estimated using 2012 calendar year average prices. Revenues were estimated using 2012 calendar year average prices for ethanol, Omaha Rack; Distiller's grains, corn gluten feed and meal, and corn oil. Prices were sourced from USDA/ERS and AMS, and EIA.

[3] See the Ethanol profitability spreadsheet maintained by Don Hofstrand "AgDecision Maker D1-10 Ethanol Profitability" available at http://www.extension.iastate.edu/agdm/energy/xls/d1-10ethanolprofitability.xlsx

Table 1
Estimated Ethanol Production Expenditures 2012

	Mil $	$/gal
Feedstocks (corn)	$33,110	$2.49
Enzymes, yeast and chemicals	$931	$0.07
Denaturant	$1,189	$0.09
Natural Gas	$1,452	$0.11
Electricity	$649	$0.05
Water	$216	$0.02
Direct labor	$783	$0.06
Maintenance & Repairs	$346	$0.03
Transportation	$100	$0.01
GS&A	$412	$0.03
Total Operating Costs	$39,189	$2.95

The largest share of spending was for the corn and other feedstocks used as the raw material to make ethanol. The ethanol industry used 4.8 billion bushels of corn on a gross basis in 2012, valued at more than $33 billion. In the absence of an ethanol industry, demand for corn would fall, prices would decline and farmers would plant and produce less corn. Land would be shifted from corn to soybeans, wheat, cotton, or other crops. Production of these other crops would increase and their prices would likely fall as well, and farm crop revenue and income would be reduced. Additionally, some land might be shifted out of crop production altogether into residential, commercial, and industrial areas.

Consequently, the ethanol industry is a major source of support for agricultural output and farm income. This analysis estimates both the total production effect and the crop price (farm income) effects of ethanol production on agriculture based on simulation of a structural model of U.S. agriculture maintained by the author.

The remainder of the spending by the ethanol industry for ongoing operations is for a wide range of inputs such as enzymes, yeast and chemicals; electricity, natural gas, and water; labor; transportation; and services such as maintenance, insurance, and general overhead.

3. Research and Development (R&D)

   The renewable fuels industry is a significant engine for research and development both in the public and private sectors. Much of the R&D activity in the biofuels industry is aimed at discovering and developing advanced biofuels feedstocks and the technology needed to meet the RFS2 targets for cellulose and advanced biofuels. The primary public sector agencies underwriting R&D in biofuels are the Departments of Energy (USDOE) and Agriculture (USDA). In addition to the federal government, many states are funding R&D in feedstocks as well as infrastructure. These public funds are being leveraged by private sector firms undertaking research in a wide range of biofuels activities. Based on a review of publically available data we assume that R&D expenditures for biofuels in the U.S. amounted to an estimated $1.7 billion in 2012.[4]

The spending associated with current ethanol production and R&D circulates and re-circulates throughout the entire economy several-fold, stimulating aggregate demand, and supporting jobs and household income. Finally, and importantly, expanded economic activity generates tax revenue for government at all levels.

Methodology

We estimate the impact of the ethanol industry on the American economy by applying expenditures by the relevant supplying industry to the appropriate final demand multipliers for value added output, earnings, and employment. To understand how the economy is affected by an industry such as ethanol production it is necessary to understand how different sectors or industries in the economy are linked to each other. For example, in the renewable fuels production sector, the ethanol industry buys corn from the agriculture sector, which in turn then buys crop protection products and fertilizers from the agricultural chemicals sector, which in turn purchases from a range of other industries. These are referred to as backward linkages. Use by other sectors of natural gas as an input, such as in manufacturing operations, is called a forward linkage. The natural gas production and transmission industries are linked through both forward and backward linkages to other economic sectors in each state's economy.

[4] For a discussion of R&D spending on biofuels see "Agricultural Preparedness and the Agriculture Research Enterprise". President's Council of Advisors on Science and Technology. Washington DC December 2012.

The household sector is linked to all sectors as it provides the labor and management needed by each. In turn, changes that affect the incomes of the household sector typically have more significant impacts compared to a change in the sales of other sectors. This is because households typically spend most of their income in both retail and service industries.

This study utilizes an economic model known as IMPLAN (Impact Analysis for Planning) to develop this understanding of the economy, including the sectors that support the ethanol industry, the links between them, and the level of economic activity. IMPLAN is a commonly used economic input-output (I-O) model. I-O models are constructed based on the concept that all industries within an economy are linked together; the output of one industry becomes the input of another industry until all final goods and services are produced. I-O models can be used both to analyze the structure of the economy and to estimate the total economic impact of projects or policies. For this analysis, a model for the U.S. economy was constructed using 2011 IMPLAN software and data (the most recent available) and used to estimate economic impacts of the ethanol industry.

IMPLAN models provide three economic measures that describe the economy: value added, income, and employment.

- Value added is the total value of the goods and services produced by businesses in the country and are generally referred to as GDP. It is equivalent to the sum of labor income, taxes paid by the industry, and other property income or profit.

- Labor income is the sum of employee compensation (including all payroll and benefits) and proprietor income (income for self-employed work). In the case of this analysis, demand for corn and other feedstocks to produce ethanol supports farm income through higher crop receipts than would be the case without ethanol production.

- Employment represents the annual average number of employees, whether full or part-time, of the businesses producing output. Income and employment represent the net economic benefits that accrue to the region as a result of increased economic output.

There are three types of effects measured with a multiplier: the direct, the indirect, and the induced effects. The direct effect is the known or predicted change in the local economy that is to be studied. The indirect effect is the business-to-business transactions required to produce the direct effect (i.e. increased output from businesses providing intermediate inputs). Finally, the induced effect is derived from spending on goods and services by people working to satisfy the direct and indirect effects (i.e. increased household spending resulting from higher personal income).

Results

The impact of the ethanol industry on the U.S. economy is summarized in Table 2. The full impact of the spending for annual operations and R&D is estimated to have contributed $43.4 billion to the nation's GDP in 2012. A significant component of this is from agriculture, reflecting the importance of ethanol demand to total corn utilization, the aggregate value of crop production, and crop receipts and farm income.

Table 2
Economic Impact of the Ethanol Industry: 2012

	GDP (Mil 2012$)	Employment (Jobs)	Income (Mil 2012$)
Ethanol Production	**$8,177**	**84,575**	**$4,831**
Direct	$783	11,971	$783
Indirect	$4,419	37,231	$2,384
Induced	$2,975	35,373	$1,663
Agriculture	**$32,399**	**267,605**	**$23,380**
Direct	$1,596	66,057	$1,240
Indirect	$16,347	42,172	$14,061
Induced	$14,455	159,376	$8,080
R&D	**$2,815**	**31,081**	**$2,035**
Direct	$967	9,264	$966
Indirect	$594	6,897	$368
Induced	$1,254	14,920	$701
Total	**$43,391**	**383,260**	**$30,246**
Direct	$3,347	87,292	$2,990
Indirect	$21,360	86,300	$16,813
Induced	$18,684	209,669	$10,444

Employment

Jobs are created from the economic activity supported by ethanol production. While ethanol production is not a labor-intensive industry, accounting for about 12,000 full time equivalent direct jobs nation-wide[5], the economic activity resulting from the full activities of the ethanol industry supports a much larger number of jobs in the economy. When the direct, indirect and induced jobs supported by ethanol production, construction activity, agriculture, and R&D activities are considered, the ethanol industry supported more than 380,000 jobs in all sectors of the economy in 2012. The distribution by economic sector of jobs supported by the ethanol industry is summarized in Table 3.

Table 3
Employment Impacts by Industry
(Full Time Equivalent Jobs)

Industry	Direct	Indirect	Induced	Total
Agriculture	66,057	15,642	4,204	85,903
Mining	0	2,332	959	3,290
Construction	0	4,862	1,781	6,642
Manufacturing	11,971	3,578	9,215	24,764
Transportation/Public Utilities	0	8,305	6,533	14,838
Wholesale/Retail Trade	0	15,670	40,015	55,686
Services	9,264	34,931	144,185	188,380
Government	0	978	2,777	3,755
Total	87,292	86,299	209,669	383,260

Since ethanol production is more capital than labor intensive, the number of direct jobs supported by the ethanol industry is relatively small and is concentrated primarily in manufacturing and agriculture. Most of the agriculture jobs supported by the ethanol industry are farm workers and laborers associated with grain production. However, a wide range of jobs in support activities related to crop production ranging from farm managers and bookkeepers to farm equipment operators are supported by ethanol production. As the impact of the direct spending by the ethanol industry expands

[5] The Census Bureau does not report employment in ethanol production.

throughout the economy, the employment impact expands significantly and is spread over a large number of sectors.

Income

Economic activity and associated jobs produce income for American households. The economic activities of the ethanol industry put more than $30 billion into the pockets of Americans in 2012. The distribution of income gains by industry are summarized in Table 4.

As is the case with employment, the direct impact on income by the ethanol industry is limited to manufacturing and construction. However the most significant impact of the ethanol industry is to increase income to farmers who benefit from the demand for feedstocks, which leads to both increased production acreage and increased prices.

Table 4
Income Impacts by Industry
(Million 2012 $)

Industry	Direct	Indirect	Induced	Total
Agriculture	$1,240	$12,361	$128	$13,729
Mining	$0	$297	$111	$408
Construction	$0	$261	$101	$362
Manufacturing	$783	$447	$739	$1,969
Transportation/Public Utilities	$0	$841	$455	$1,296
Wholesale/Retail Trade	$0	$697	$1,630	$2,327
Services	$966	$1,826	$7,046	$9,838
Government	$0	$84	$234	$317
Total	$2,990	$16,813	$10,444	$30,246

Tax revenue

The combination of GDP and household income supported by the ethanol industry accounted for nearly $4.6 billion of the revenue received by the Federal Treasury in 2012. State and local governments also benefit from the economic activity supported by the ethanol industry earning $3.9 billion in 2012.

Crude oil displacement

Ethanol reduces our dependence on imported oil and reduces the U.S. trade deficit. The production and use of ethanol displaces crude oil needed to manufacture gasoline. According to the Energy Information Administration, U.S. dependence on imported oil has dramatically declined since peaking in 2005. EIA credits increased use of domestic biofuels (ethanol and biodiesel) as one of the factors contributing to the steady decline in oil import dependence. EIA reports that in 2011 imports accounted for 45 percent of our crude oil and refined petroleum supplies and oil imports, compared to 60 percent in 2005.[6] Moreover, oil and refined petroleum products are the largest component of the expanding U.S. trade deficit. The production of 13.3 billion gallons of ethanol means that the U.S. needed to import 465 million fewer barrels of oil in 2012 to refine gasoline. This is roughly the equivalent of 12 percent of total U.S. crude oil imports.[7] The value of the crude oil displaced by ethanol amounted to $47.2 billion in 2012.[8] This is money that stays in the American economy.

Challenges for 2013

The renewable fuels industry faces significant challenges in 2013. Perhaps the most significant will be continuing to deal with the effects of the 2012 drought on corn supply and prices until the harvest of 2013 crop begins. Further, as 2013 began, much of the Corn Belt remained under drought conditions. However, normal moisture in the spring and a return to more normal yields accompanied with large spring plantings would result in a large harvest and would put downward pressure on commodity prices – and feedstock costs. However, feedstock supplies will remain tight until the 2013 corn crop is "in the bins."

[6] EIA. *Energy in Brief*. "How dependent are we on foreign oil?" http://www.eia.gov/energy_in_brief/foreign_oil_dependence.cfm. July 13, 2012

[7] According to EIA the U.S. imported 4,161 million barrels of crude oil and petroleum products in 2011. Imports for 2012 (January through October) are running nearly 7 percent below year-earlier levels. http://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbbl_m.htm

[8] Ethanol directly competes with and displaces gasoline as a motor fuel. According to EIA one 42 gallon barrel of crude oil produces 18.8 gallons of gasoline in 2012. Ethanol has a lower energy content (76,300 btu/gal) than gasoline (116,000 btu/gal) so it takes 1.52 gallons of ethanol to provide the same energy as a gallon of gasoline. Therefore, 13.3 billion gallons of ethanol are the equivalent of 8.7 billion gallons of gasoline. Since one barrel of crude produces 18.8 gallons of gasoline, it takes 465 million barrels of crude to produce 8.7 billion gallons of gasoline, the amount displaced by ethanol. This oil was valued at the 2012 average composite acquisition cost of crude oil by refiners of $101.53/bbl.

The health of the economy and future of petroleum prices also provide challenges for the industry. Continued slow growth in consumer spending and high oil prices would further constrain gasoline and diesel fuel consumption. Since ethanol is blended with gasoline, declines in gasoline consumption translate into weak demand for renewable fuels. This is a particular issue for the ethanol industry since the E10 blend wall has been met and the primary way to increase consumption is through the sale of higher blends. The EPA approved the use of E15 blends for most automobiles on the road; however, E15 sales have been slow to date. Much broader consumption of E15 is necessary not only to meet the requirements of the RFS, but also to meaningfully increase ethanol demand and prices. The oil industry will continue to support and encourage attacks on the RFS and put up hurdles to increased penetration of higher ethanol blends.

Finally, public policy and regulatory issues also present challenges. On January 2, 2013, President Obama signed into law H.R. 8, the American Taxpayer Relief Act (ATRA), known more commonly as the Fiscal Cliff deal. The focus of the legislation was aimed at averting a complete expiration of the 2001 and 2003 Bush tax cuts. This law included the extension and modification of energy tax provisions impacting numerous industries. The ATRA includes a Cellulosic Biofuel Producer Credit that extends the current $1.01 per gallon tax credit for the production of cellulosic biofuels through 2013. Such a short-term extension is unlikely to give investors the market certainty they need to make substantial investments in next-generation biofuels.

Conclusion

Despite a challenging year in 2012, the ethanol industry continues to make a significant contribution to the economy in terms of job creation, generation of tax revenue, and displacement of imported crude oil. The importance of the ethanol industry to agriculture and rural economies is particularly notable. Continued growth and expansion of the ethanol industry into new technologies and feedstocks will enhance the industry’s position as the original creator of green jobs and will enable America to make further strides toward independence from imported fossil fuels.

Research Article

Global economic effects of US biofuel policy and the potential contribution from advanced biofuels

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Background: This study evaluates the global economic effects of the current US RFS2, and the potential contribution from advanced biofuels. **Results & discussion:** Our simulation results suggest that these mandates lead to an increase of 0.21% in the global gross domestic product in 2022, including an increase of 0.8% in the USA and 0.02% in the rest of the world, relative to our baseline no-RFS scenario. The incremental contributions to gross domestic product from advanced biofuels in 2022 are estimated at 0.41 and 0.04% in the USA and the rest of the world, respectively. **Conclusion:** Although production costs of advanced biofuels are higher than for conventional biofuels in our model, their economic benefits result from reductions in oil use and their smaller impacts on food markets compared with conventional biofuels. Thus, the US advanced biofuels targets are expected to have positive net economic benefits.

The RFS portion of the US **Energy Independence and Security Act** of 2007 (EISA) requires 36 billion gallons of biofuels to be blended with liquid transportation fuels by 2022 [1]. This policy is often referred to as the RFS2 because it is an extension of a more modest RFS1 that was put in place in 2005 and required 7.5 billion gallons of renewable fuel by 2012. The biofuels recognized under the RFS2 can be broadly divided into conventional and advanced categories. These biofuel categories are defined by a combination of feedstock sources and thresholds for reductions in their life cycle emissions of GHGs. Conventional biofuels, which are mainly produced from corn starch in the USA, are required to meet a threshold of 20% reduction in life cycle GHG emissions relative to their fossil-fuel equivalents. **Advanced biofuels**, including biodiesel and fuels produced from cellulosic and other feedstocks, are required to meet a threshold of 50% reduction in life cycle GHG emissions.

The annual volumetric targets for the different biofuel categories under the RFS2 and production levels since 2001 are shown in **Figure 1**. Conventional biofuel production in the USA, almost entirely corn ethanol, grew rapidly between 2001 and 2010, and is approaching the target for this category under the RFS2. Conversely, the production of advanced biofuels (except biodiesel) has been slower than anticipated under the RFS2 policy. The US EPA, which is tasked with enforcing the RFS2, has lowered the actual cellulosic biofuel requirements several times to align the targets with realized production capacity. In 2010 and 2011, the adjusted targets were less than 7 million gallons, whereas the RFS2 called for 100 and 250 million gallons of cellulosic biofuels in those two years, respectively. Still, the advanced biofuel tracking database shows that, as of the first quarter of 2011, the planned capacity for cellulosic biofuel production in the USA is projected to reach 640 million gallons by 2014 [101].

Biofuel R&D efforts in the USA have recently shifted to include the production of drop-in biofuels. Drop-in biofuels *"can be blended with the petroleum derived counterparts or used directly in gasoline, diesel or jet engines"* [102]. The shift in focus to drop-in biofuels was motivated by the recognition that expansion of ethanol at

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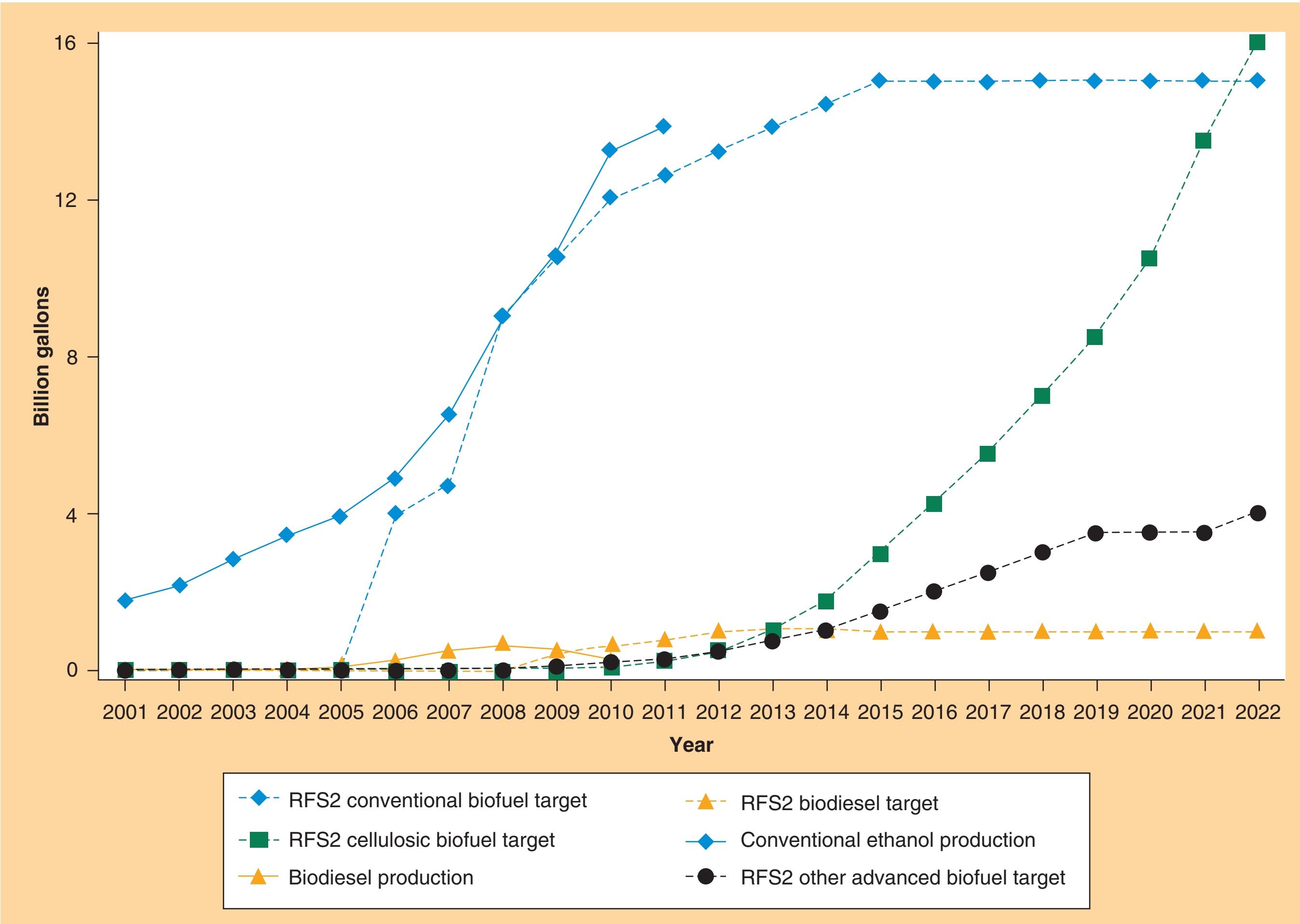

Figure 1. Biofuel policy targets under the US RFS2 and production from 2001 to 2011.

the scale envisaged under the RFS2 might require large changes to the supply infrastructure and vehicle fleet. In addition, the objective of reducing oil imports requires substitutes for the entire barrel of oil, not just the gasoline portion displaced by ethanol. However, advanced biofuel technologies, particularly for drop-in biofuels, are still in the development and demonstration stages.

Notwithstanding its slow pace of development, the transition to advanced biofuels is crucial to maintain the current momentum in developing alternatives to fossil-based liquid fuels. Global petroleum prices have recovered to almost 2008 peak levels, despite a global economic recession that has been referred to as the "worst recession since the second World War" [2]. The high cost and environmental impacts of fossil fuels call for a better understanding of the costs and benefits of alternatives and a long-term plan for reducing dependence on petroleum fuels. These assessments need to be conducted on a global basis to account for crucial market interactions that may hinder or spur the development of domestic biofuels. In addition, global sustainability issues, such as food security and GHG emissions from land use change, have become important in relation to conventional biofuel production over the last several years [3]. These global sustainability issues are also relevant to the development of advanced biofuels in the USA and abroad.

There are several existing studies on the economic effects of biofuel policies. The approaches employed in these studies include partial equilibrium (PE) and general equilibrium (GE) models. The analyses in this paper use a **computable GE (CGE) model** of the global economy. A major advantage of GE models is the comprehensive modeling of economic transactions, including production, consumption, government, trade, savings and investment. Thus, these models are able to account for the wide range of market forces that determine the economic effects of biofuels. However, the comprehensive scope of these models means that, in order to be tractable, not all aspects of the economy can be specified in great detail. PE models concentrate on one or a few sectors that may be specified in considerable detail. For biofuel analyses, the focus is usually on the agricultural and fuel sectors of the economy. However, PE models by design cannot account for economy-wide influences that may be crucial to the effects of biofuels, which are captured in GE models. A number of studies most relevant to the current study are summarized below.

Gelhar *et al.* used a CGE model of the USA (USAGE) to examine how meeting the RFS2 would affect the economy [4]. The study found that, with advances in cost-reducing technology and continuing high oil prices, the RFS2 would provide positive economy-wide benefits. Taheripour *et al.* used the Global Trade Analysis Project (GTAP)-Biofuels CGE model to examine the agricultural impacts of USA and EU mandates with and without accounting for the byproducts of biofuel production [5]. Their results suggest that biofuel policies lead to significant changes in the pattern of agricultural production across the world, and that omitting byproducts overstates cropland conversion. Zhang *et al.* provide an overview of the agricultural impacts of biofuel growth from four PE and five GE models [6]. The PE models projected increases of between 14 and 53% in global and US corn prices, with corresponding increases of between 2.9 and 18.9% in corn production. Estimates of increases in corn price and production from the GE models are 5–45% and 4–53%, respectively. In the Chen and Khanna study, which uses a dynamic programming model of the US agricultural and fuel markets, corn and soybean prices increase by 20–50% in 2022 under three scenarios with different combinations of the RFS2, biofuel tax credits and tariffs on ethanol imports [7]. Estimates of the economic impacts of biofuel policies in other regions are also mixed [8–14].

This article presents a dynamic assessment of the economic effects of the RFS2 biofuel targets using the GTAP-dynamic energy policy simulations (DEPS) model [15]. Most of the existing models of biofuel policy are static and consider oil prices to be exogenous; however, the GTAP-DEPS model is a multiregional, global CGE economic model that incorporates cellulosic biofuels, dynamics and other enhancements to enable a robust simulation of the evolution and impacts of biofuel policy. Prices of fossil fuels and biofuels are determined endogenously, allowing the model to capture the crucial effects of biofuel policies on energy markets, and their implications for the domestic and global economy. The dynamic simulations and endogenous determination of biofuel feedstocks allow an explicit evaluation of the specified path for meeting the RFS2 targets. This approach helps to reveal important time-related effects of biofuels that would not be captured by static or sequential static simulations, in which changes in the capital stock and investment are not required to be consistent. In addition, our policy simulations capture the design and implementation of the RFS2 as a share mandate. Most previous studies have modeled the RFS2 as a combination of subsidy to biofuels and tax on petroleum; however, the equivalence of these two policies in PE does not carry into the GE framework [16].

The rest of the article is arranged as follows: the next section provides an overview of the GTAP-DEPS model and describes the approach for introducing cellulosic biofuels into the model in the context of the transition from conventional to advanced biofuels; the next section describes the scenarios simulated with the model and the results; and the article ends with a summary and conclusion section.

Method & data

We employ a CGE modeling framework to evaluate the global effects of US biofuel policies. CGE models are mathematical representations of the behavior of agents (e.g., households, industries, government and investors) that make up an economy. These economic agents optimize their individual objectives over multiple commodities and markets. Consumers maximize their utility from the purchase of goods and services, and provide labor, capital, land and other primary factors of production to the economy, whereas producers minimize their costs of production (or maximize their revenue). The full CGE model is an exactly identified system of equations (i.e., an equal number of equations and variables) of demand and supply for all commodities, income accounts and other equations necessary to represent the workings of an economy. The solution to a GE model is found by solving for the quantity and price pairs that simultaneously balance supply and demand in all commodity markets, while satisfying consumer budget constraints, zero profit conditions (i.e., revenue equals cost) for producers and constraints on the availability of resources.

The empirical CGE model employed here is based on the multiregional GTAP modeling framework. The standard GTAP model documented by Hertel incorporates only a few sectors and regions and a single

Key terms

Energy Independence and Security Act: An energy policy law by the US congress. The stated purpose of the act is *"to move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles, to promote research on and deploy GHG capture and storage options, and to improve the energy performance of the Federal Government, and for other purposes."*

Advanced biofuels: Group of biofuels included in the US Energy Independence and Security Act RFS2 that are generally produced from cellulosic and other nonstarch feedstocks including sugarcane, and emit at least 50% less GHGs relative to their fossil-fuel equivalents on a lifecycle basis.

Computable general equilibrium models: Exactly identified system of equations that represent the behavior and interactions among different actors within an economy. These models impose simultaneous equilibrium between supply and demand in all markets, and the equality of incomes and expenditures. Computable general equilibrium models are particularly suited for estimating the effects of changes in one part of the economy on the rest of the economy.

Key terms

Constant elasticity of substitution: Functions that exhibit the constant elasticity of substitution property. The elasticity of substitution measures how the quantity ratio of two inputs or commodities changes in response to changes in the ratio of their prices.

Armington assumption: Used in computable general equilibrium models to accommodate the observation that countries exchange seemingly identical commodities, known as cross hauling. The assumption is that products traded internationally are differentiated on the basis of their country of origin and are therefore imperfect substitutes. This allows such goods to have different prices in each country.

year [17]. Practical applications generally build on the standard GTAP model by increasing the number of sectors and regions, and by incorporating more sophisticated specifications of economic activities. For the purposes of the current study, we have used the GTAP-E version of the model as a starting point, and incorporated several modifications designed to enable a robust simulation of biofuel policy [18]. The resulting model, tagged GTAP-DEPS, is an adaptive-expectations recursive dynamic CGE model of the global economy. It includes 18 world regions and 33 economic sectors, with one of these sectors representing the production of investment goods. An overview of the model is provided below.

Overall structure of the GTAP-DEPS model

The nesting structure for production activities in the model is illustrated in Figure 2. Each nest is modeled using a **constant elasticity of substitution** (CES) cost function. The output of a given sector is the combination of four inputs: a value-added/energy composite; cellulosic feedstock (for cellulosic biofuels sectors); coarse grains/vegetable oil/distiller's dry grains with solubles (DDGS) composite; and a composite of other intermediate inputs in the top nest of the production structure. Each composite input is made up of additional subnests. The value-added/energy composite input consists of skilled and unskilled labor, land, natural resources and a capital/energy composite. The composite coarse grains/vegetable oils/DDGS input enables the modeling of DDGS as a substitute for two other feed inputs into livestock production (i.e., oilseed meal and coarse grains). Since DDGS is a byproduct of corn ethanol production, it is represented as a fixed coefficient function of corn ethanol production and its price adjusts freely to accommodate this constraint. The capital/energy composite consists of the capital stock and total energy demand. Energy is further made up of successive subnests of different energy sources. In particular, a composite biofuel commodity (biodiesel and ethanol) substitutes for petroleum products based on biofuel categories similar to those in the RFS2 policy. Ethanol is a combination of conventional ethanol (produced from coarse grains in the model) and advanced ethanol, with the latter including sugarcane ethanol and cellulosic ethanol. Cellulosic ethanol is produced in the model from biochemical and thermochemical processes. Finally, cellulosic feedstock inputs consist of herbaceous and short-rotation energy crops and residues. Residues are derived from coarse grains, other crops and forestry in the model.

Incomes from factor supply, taxes and other sources accrue to an aggregate regional household. Incomes received by the aggregate regional household are distributed to a private household, government and capital account (savings) with fixed shares. The government's income is allocated to goods and services according to a Cobb–Douglas utility function, whereas purchases of goods and services by the private household are based on a constant differences in elasticities expenditure system [19]. International trade in goods/services is modeled with a two-level nest of CES functions based on the **Armington assumption** of imperfect substitution among goods and services from different regions. The demand for each good or service is modeled for each type of buyer (private household, government and producers) as a composite of purchases from domestic and foreign markets. A market-clearing condition ensures that total domestic production is equal to the sum of domestic sales and exports.

Modeling of primary factor supply

Total agricultural land use in each crop, forestry or pasture sector is a combination of land from different agroecological zones (AEZs). AEZs partition the land in each region into 18 productivity categories using a combination of climate types (three categories) and length of growing periods (six categories). The land use submodel in Figure 2 captures the relative substitutability among AEZs in crops, forestry and pasture production activities. The regional demand for agricultural land in a given AEZ is the sum of land use over all crops, forestry and pasture activities. Figure 3 illustrates the land supply submodel of the GTAP-DEPS model. Total land cover in each regional AEZ is allocated to three aggregate cover types: forests, composite shrub/grass/agricultural land and other land cover (made up of built-up/other uses). The composite shrub/grass/agricultural land is in turn the combination of shrub/grass and agricultural lands. This two-level nesting attempts to capture the fact that shrubland/grassland is more easily converted to agriculture, and represents the transition pathway from standing forest land to agricultural land. The land supply structure in Figure 3 is implemented using constant elasticity of transformation functions (CET). Prices for the three nonagricultural land cover categories on the supply side of the model were set and held at 1. This is a common approach in CGE models, where price indices are set to 1 during calibration, allowing the economic values to represent quantities. In this case, this allows us to keep quantities in physical terms (i.e., hectares) in the land supply submodel while the land use subnest in Figure 2 is in economic terms (dollars). Constant prices for these three land cover categories also mean that only changes in agricultural land prices drive the reallocation of land among the four land cover categories. The land supply submodel generates an upward sloping supply curve as agricultural land rent changes. The intersection of this supply curve with the derived demand curve from land-using sectors determines equilibrium prices for agricultural land supply/use in each AEZ.

The yield implications of changes in the size and distribution of agricultural land occur on the land use side of the model, but the effects are transmitted to the supply submodel through percentage changes in quantities and prices. There are intensive yield changes as relative prices of agricultural inputs change within the CET function. The model also includes separate nonintensive yield functions with both nonprice (trend) and price-driven components. The price-driven component captures yield changes that are not directly associated with the substitution of other inputs for land but may be motivated by changes in the price of agricultural commodities, such as changes in rotation, among others. In the model, this component responds to the price of the value-added/energy composite input in Figure 2, where land enters the production structure.

The supply of labor and natural resources are modeled as functions of the wage rate and resource rents, respectively. Supplies of skilled and unskilled labor are constant elasticity functions, with intercepts that are specified exogenously to represent the population-driven change in the labor force. Similarly, supply functions for each of the four natural resources in the model (oil, coal, natural gas and other resources) are specified separately since each resource is the exclusive endowment for the production of crude oil, coal, natural gas and other industry/services, respectively. The endogenous representation of energy resource costs is crucial to the interaction between fossil and biofuel energy markets, which in turn is important to measuring the economic effects of biofuel policy.

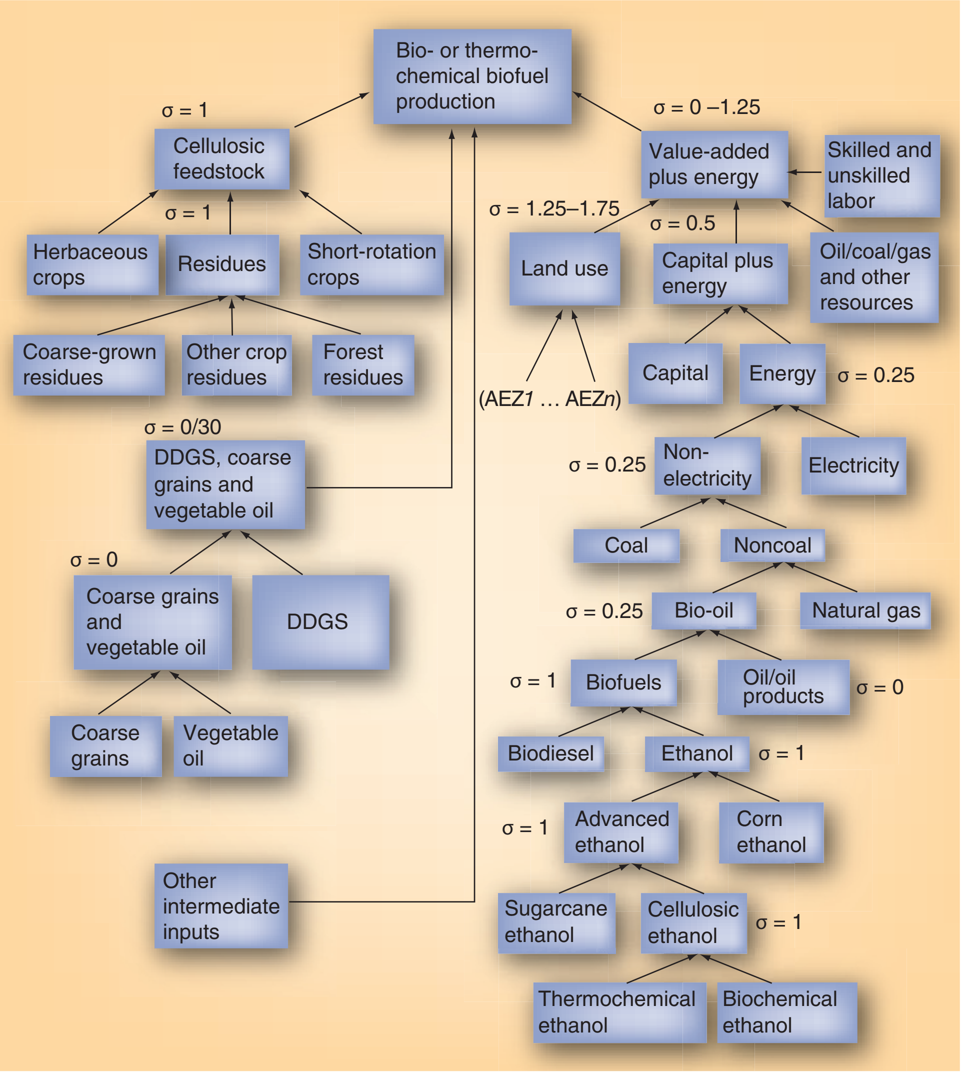

Figure 2. Structure of production activities in the Global Trade Analysis Project dynamic energy policy simulations model.
σ: Elasticity of substitution; AEZ: Agroecological zone; DDGS: Dried distiller's grains with solubles.

▪ Dynamics of capital allocation & investment

The GTAP-DEPS model incorporates the explicit dynamics of regional capital stock accumulation, international assets/liabilities, international

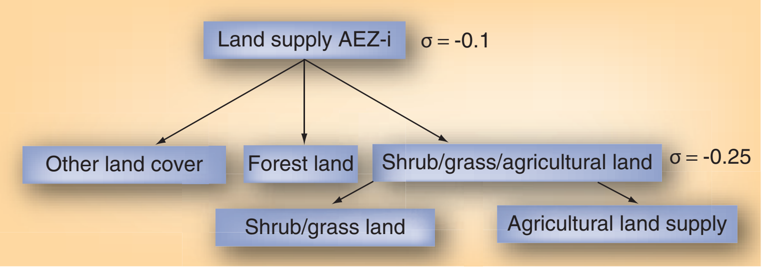

Figure 3. Supply and demand of land in each agroecological zone.
σ: Elasticity of transformation; AEZ: Agroecological zone.

investment/income flows and financial assets, as described in Ianchovichina and McDougall [20]. Investment decisions are based on adaptive expectations theory with an error-correction mechanism for determining the expected rate of return. The incremental adjustment to the long-run equilibrium implied by the error-correction approach provides a more realistic representation of the dynamics of economic behavior than myopic and perfect foresight specifications. In place of a full bilateral investment and equity matrix, a global trust serves as an intermediary that 'manages' foreign investments on behalf of all regions. Equations are specified for tracing changes in the distribution of regional household wealth between domestic and foreign equity, as well as changes in the distribution of the assets of the global trust among regional firms. Incomes from regional firms, consisting of capital earnings, are distributed to regional households and to the global trust in proportion to their equity shares. In turn, incomes received by the global trust are distributed to regional households in proportion to their shares in the global trust.

The above dynamics of capital and international investment/income flows have been incorporated in the GTAP-DEPS model with a number of important changes. In the original formulation, the allocation of household wealth and international investments is based on an atheoretic cross-entropy portfolio-optimization approach. In the GTAP-DEPS implementation, the associated model equation has been replaced by a function in which the ratio of household assets in local equity to assets in the global trust responds to the ratio of local and global trust asset prices according to a given elasticity parameter. In addition, the distribution of net regional capital earnings and global trust income is based on initial, rather than final, domestic and foreign wealth/equity shares. Thus, while regional households and the global trust reoptimize the allocation of their equity/wealth during the current period, the changes do not affect income allocation until the next period. This specification matches the fact that new investments in capital, which are determined by regional household and global trust wealth allocation decisions, are not productive until the following period. Changes in the equity value of regional firms are explicitly specified as equal to the value of new investments. In addition, the regional capital stock in the current period, which is the sum of capital stock and investment from the previous period (net of depreciation), is held fixed in the GTAP-DEPS model. Finally, the allocation of regional capital stock among firms is determined using a CET function according to the ratio of sectoral capital rental rates to the regional average rate. The elasticity parameter of the CET function can be set to make the movement of regional capital among firms sluggish or mobile, rather than perfectly mobile as in the standard GTAP model.

Cellulosic feedstock supply curves

Data for modeling the costs, availability and land use of cellulosic feedstock in the USA are based on the Billion-Ton Update (BT2) study recently completed by a joint team of US Department of Energy National Laboratories, US Department of Agriculture and universities [21]. Note that, in order to incorporate cellulosic biofuel technologies into the model, small amounts of cellulosic biofuels production were introduced to the underlying 2001 global economic database. However, no cellulosic resources for biofuel production were included in the model for regions other than the USA. Projected cellulosic feedstock data from the BT2, spanning the period from 2009 to 2030, were aggregated for the needs of the GTAP-DEPS model as follows:

- Coarse grains residue: corn stover, sorghum stubble, oats straw and barley straw;
- Other grains residue: wheat straw;
- Herbaceous energy crop: switchgrass and sweet sorghum;
- Short-rotation woody crops: poplar and willow;
- Forest residues: forest residues and thinnings, and other thinnings.

Price and quantity data for the above feedstock categories can be used to generate step-supply functions, but these are difficult to implement within large GE models. Instead, these supply functions were fitted to smooth functions that could be incorporated in the GTAP-DEPS model. This approach is similar to those employed in other CGE studies. Rose and Oladosu fitted polynomial functions to supply curve data for forest carbon sequestration from simulations with a PE optimization model of forestry operations in USA. These functions were then incorporated in a CGE model [22]. Similarly, Pizer *et al.* used results of carbon price simulations with PE models to estimate the parameters of reduced form functions for a CGE model [23].

In the current study, national production data for crop and forest residues were fitted to the price data. For energy crops, land supply data in each AEZ were fitted to a function of national production and price based on the need to provide both yield and land use information to the model. The data used here corresponds to the BT2 baseline yield scenario with a fixed nominal payment of US$80/ton for cellulosic feedstock. The price/cost data were deflated to 2001 to match the base year of the GTAP-DEPS model. Figure 4 presents examples of the resulting step-supply curves from the BT2 study and the fitted supply functions, showing a good fit to the data, even when the step curves are irregular.

Cellulosic ethanol production technology data

Data for representing the two cellulosic biofuel production technologies shown in Figure 2 in the model were derived mainly from Tao and Aden, which presented conversion cost data on the biochemical conversion of corn stover and the thermochemical conversion of wood chips to ethanol [24]. The data included per gallon and total costs for a 45 million gallon per year mature technology plant. Cost items for the technologies include feedstock, corn steep liquor, cellulase, catalysts, olivine, other raw materials, waste disposal, electricity, fixed costs, capital depreciation, income tax and return on investment. Items such as fixed costs and raw materials were further disaggregated by consulting the original technical studies [25,26]. The resulting data were categorized according to the production inputs in the model. Table 1 shows the resulting data table from which the input–output coefficients were calculated and used to incorporate the two cellulosic production processes in the underlying GTAP-DEPS database, as discussed in the next section.

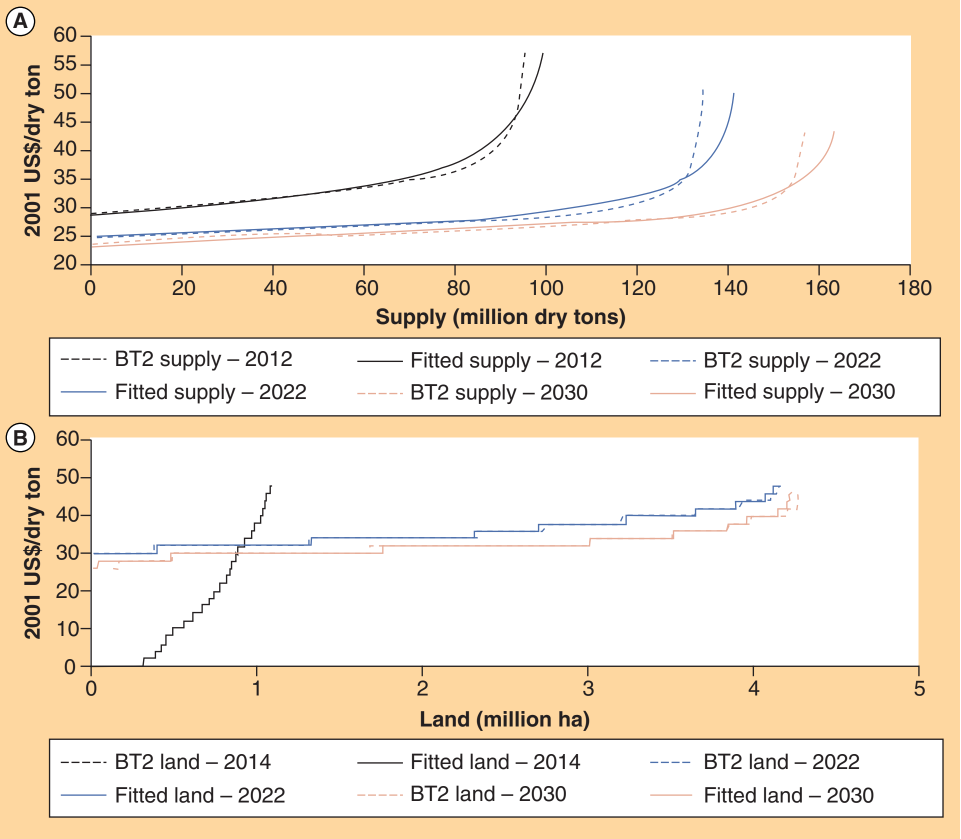

Figure 4. Illustration of the estimated supply curves based on Billion-Ton Update baseline data. (A) Production of residues and **(B)** land for herbaceous energy crops.
BT2: Billion-Ton Update.

Model data & parameters

The global economic data for the GTAP-DEPS model are based on a modified version of the GTAP-6 database, which added corn ethanol, sugarcane ethanol and biodiesel to the original global economic data [27]. The

Table 1. Cost items for cellulosic biofuel production processes in Global Trade Analysis Project dynamic energy policy simulations model.

Cost items	Biochemical process†	Thermochemical process‡
Other industries and services	1.545	1.926
Oil products	0.000	0.100
Other food processing	1.400	0.000
Chemicals	6.900	0.500
Unskilled labor	2.201	2.454
Skilled labor	0.996	1.540
Capital	30.312	33.653
Feedstock	23.000	25.800
Production tax	0.845	1.726
Total output costs	67.200	67.700
Unit cost (US$/gal): 45 MM gal/year	1.490	1.500

†Corn stover feedstock; million US$ – 2007.
‡Wood chips feedstock; million US$ – 2007.
Data taken from [23–25].

Key term

Social accounting matrix: Complete table of transactions among all agents within a given economy. The rows represent receipts, and the columns represent payments. Each row and column must balance. Rows and columns of the social accounting matrix usually include firms, households, government, trade and taxes, among others.

database contains global data on production, consumption, trade and investment, and includes 57 economic sectors and 87 world regions. In addition, it includes default values for parameters of the household-expenditure system, input factor substitution and Armington elasticities for the substitution between domestic and imports of goods/services. The database was aggregated and further modified in accordance with the model structure presented above. The main changes are explained below.

Modification of the social accounting matrix

The GTAP database was converted into a **social accounting matrix** (SAM) format and new sectors related to biofuels were added. These new sectors include the two cellulosic-ethanol processes (biochemical and thermochemical). Feedstock inputs for cellulosic ethanol production include crop and forest residues, herbaceous energy crops and short-rotation forestry crops. Residues were added to the data as a new endowment accumulated as a constant coefficient of production by the crop and forestry sectors of the model in each year. The herbaceous energy crop sector was split out of the existing 'other grains' sector, while the short-rotation woody crop sector was split from the 'forestry' sector. A sector that purchases DDGS from the corn ethanol sector and sells it in the domestic and export markets was also added to the SAM. The resulting SAM was then rebalanced and used to generate a new database matching the structure of the GTAP-DEPS model.

Land data

In addition to the economic database, the SAGE land use database [103] for the GTAP6 database [28] was aggregated to match the sectors and regions in the model. The SAGE database is the basis for disaggregating the global land data into 18 AEZs. Each AEZ is characterized by seven landcover categories that were combined into the four primary land cover types used in the model.

Dynamic variable forecasts

A baseline forecast of variables is required to simulate the dynamic model. An overview of the database and the procedure for projecting a future baseline are provided in McDougall *et al.* [29] and Walmsley [30]. The main exogenous variables projected for the GTAP-DEPS model are population, gross domestic product (GDP) and labor supply. Projections for these variables were performed by estimating yearly growth rates rather than their levels. Since values may be missing for a few countries in a given region, this approach allows the available data to be used as a sample to calculate average growth rates for each region of the model. Projections for the current study employed data from the World Development Indicators (WDI) database [104] and the World Economic Outlook (WEO) database [105]. The WDI includes data for 237 countries and a comprehensive set of measures for economic and human development from 1960 to 2008. The WEO provides historical and projected data from 1980 to 2015 for 187 countries. We used the WDI to estimate regional growth rates of population, labor and real GDP from 1991 to 2008. Although the WEO includes many other variables, only the population and real GDP were consistently available for most countries. To project the labor supply data from 2001 to 2015, the average labor to population growth rate ratio was estimated from the WDI data for 2004–2007 and applied to the population growth rate estimated from the WEO data. Growth rates of all projected variables for 2016–2030 were set to the estimate for 2015.

Model parameterization

Elasticity of substitution/transformation parameters for the production and land supply submodels are as shown in **Figures 2 & 3**. Many of these elasticities are comparable with values used in previous studies [31]. Substitution parameters for the new biofuel-related structures in **Figure 2** are set to 1 since there are no existing estimates for these parameters. This implies a Cobb–Douglas function, in which the value shares of components are maintained by adjusting relative quantities proportionally to the changes in relative prices. Other parameters are adapted from the underlying GTAP database. The elasticity parameters for the labor, coal, oil, natural gas and other natural resource supply curves were chosen as follows.

The supply elasticity for labor was assigned a value of 0.2. Parameters for oil, coal and natural gas supplies were estimated by fitting the supply data over the last decade to global prices. The estimated regional supply elasticities range from 0 to 0.61 with an average of 0.16 for oil, 0–1.10 with an average of 0.26 for coal and 0–1.27 with an average of 0.48 for natural gas. In addition to those needed for the static model, several additional parameters are required for the dynamic components of the model. These values were set based on discussions in Golub and McDougall [32]. The intercepts of the nonintensive yield functions were used to specify the trend rate of increase in yields. Values for the three main crop groups (coarse grains, oilseeds and other grains) were set as two-thirds of the average percentage increases in yield from 2001 to 2009 in each region. These were calculated from the Production, Supply and Distribution Database [106]. This assumption was made to keep the trend rate in coarse grains yield in the USA close to the empirically estimated rate for corn in Tannura *et al.* [33]. For the USA, these values were 1.86% for coarse grains, 1.65% for oilseeds and 0.79% for other grains. Most of the estimates for all regions were between 1 and 2.5%, with only Japan having negative values of between -0.8 and -0.08%. Estimates of crop yield elasticity for the price-driven component of the nonintensive yield function for the USA were derived for coarse grains (corn), oilseeds (soybeans) and other grains (wheat) from Huang and Khanna [34] at 0.15, 0.06 and 0.43, respectively. The remaining 17 regions of the model were then given half of these values. The resulting elasticities for other grains were also applied to the other land using sectors (i.e., sugarcane, other agriculture and the three livestock sectors).

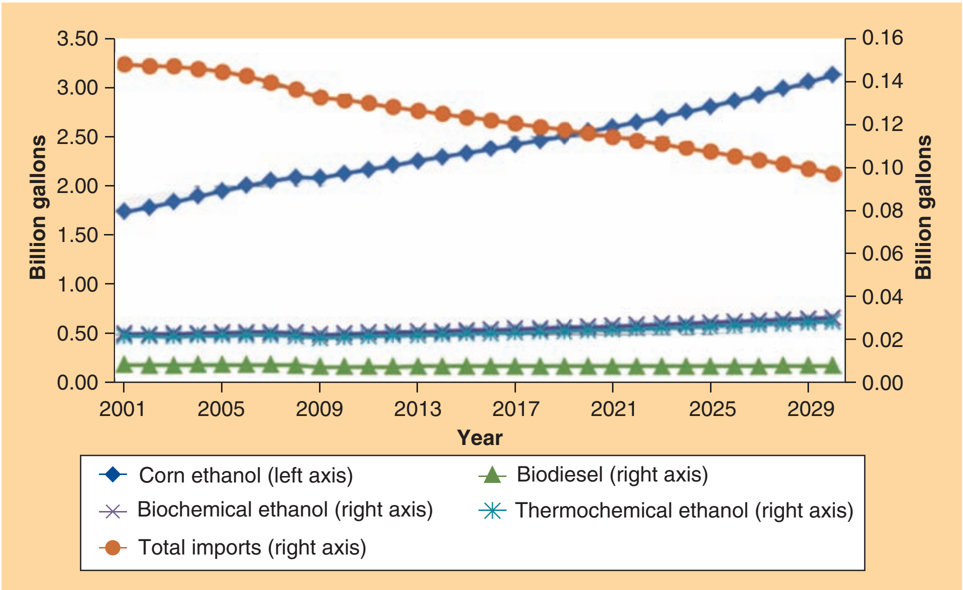

Figure 5. Production and imports of biofuels in the USA in the baseline simulation.
Note: different scale on second axis.

Simulations of biofuel scenarios

▪ Model calibration & baseline simulation

The GTAP-DEPS model was calibrated by making the regional gross domestic growth rates exogenous and setting these to the projected levels, while making the average regional productivity of primary factors (excluding capital) endogenous to rebalance the model. After the calibration, a baseline run of the model was generated by holding the regional productivity parameters at the calculated levels and making regional GDP endogenous once again. **Figure 5** illustrates the production and imports of biofuels under the baseline simulation, showing only small increases over the horizon. The baseline simulation assumes that renewable biofuel standards were not implemented during the entire simulation period from 2001 to 2030. Corn ethanol production in the baseline simulation grew from approximately 1.74 billion gallons in 2001 to almost 3 billion gallons in 2030, whereas the production of other biofuels remained largely flat. Despite the significant increases in oil prices, the low elasticity of substitution between biofuels and petroleum in the USA led to a slow increase in the use of biofuels in the baseline simulation.

Price and quantity indices for global agricultural and energy commodities in the baseline simulation are shown in **Figure 6**. **Figure 6A** contains the real price indices for these commodities relative to 2001. Real agricultural prices were largely stable between 2001 and 2006, increased slightly from 2007 to 2011, then declining slowly until 2030. The pattern of agricultural prices in the baseline simulation reflects the combination of assumptions on crop yields and global economic growth. For example, the slight increase in prices by 2007 reflects the strong growth of the economy between 2003 and 2007, whereas the declines show the effect of both the 2008/2009 recession and constant growth rates of the regional economies from 2015 to 2030. Prices for oil, coal and natural gas grew almost steadily over the simulation period, which is consistent with steep fossil fuel supply curves under a tight energy market. The oil price index rose to approximately 5 in 2030, or approximately $125 per barrel in real terms, given a $25 per barrel price in 2001. The growth rates of the price indices for coal and natural gas are somewhat slower with their indices at approximately 2 in 2030.

Indices in **Figure 6B** show a largely steady increase in commodity production over the entire simulation period. There was a slight slowdown between 2008 and 2009 due to the global recession. As expected from a tight energy market, oil, natural gas and coal have the slowest production growth paths in **Figure 6**. Among the agricultural commodities, nonruminant livestock had the fastest growth path. However, the next three highest paths were for oilseeds, other grains and coarse grains/sugarcane, respectively. These baseline production indices are projections, rather than forecasts. Still, these results represent the essence of changes in the demand for energy and food, based on the characteristics of the

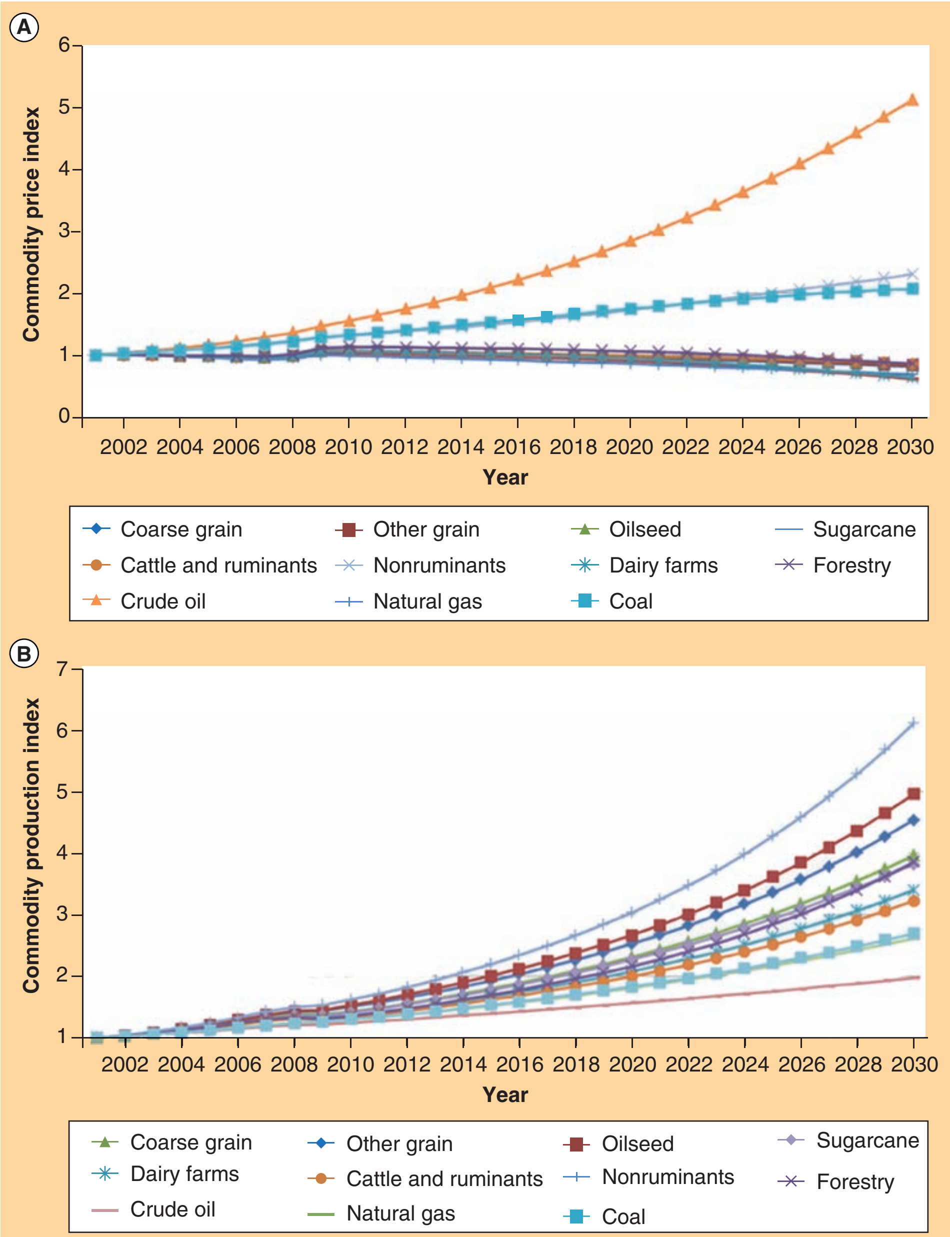

Figure 6. Agriculture and energy commodities in the baseline simulation. (A) Price indices and **(B)** production indices.

GTAP-DEPS model and assumptions about population and economic growth incorporated into the baseline simulation.

EISA RFS2 simulation scenarios

Simulations with the model require that appropriate variables representing the biofuel policy be exogenously shocked. The RFS2 policy in the USA is implemented as increases in the overall share of biofuels in liquid transportation fuel, as well as changes in the relative shares of different biofuel categories over time. Percentage shifts in the components (biofuel, q_i and petroleum, q_j) of a fixed level of the biofuel-petroleum mix (q) can be derived as follows:

$$\%q = s_i\%q_i + s_j\%q_j = 0$$

Equation 1

$$\%q_j = -\left(\frac{s_i}{s_j}\right)\%q_i$$

Equation 2

The parameters, s_i and s_j, are the initial shares of the components and sum to one. When prices are equal to one, which is the usual approach in calibrating CGE models, these parameters are equal to the share parameters of the CES function used to model biofuels and petroleum products as shown in **Figure 2**. The objectives of the RFS2 policy can be interpreted as shifts in these parameters given the representation of petroleum–biofuel blending with a CES function in the model. This was implemented in the GTAP-DEPS model by including new parameters to represent the percentage changes in **Equation 2**. In the policy simulations, these parameters become endogenous for total biofuel, biodiesel, corn ethanol and sugarcane ethanol; whereas the demands for biodiesel, sugarcane ethanol, corn ethanol and cellulosic ethanol become exogenous. After the last year of each policy simulation these parameters become exogenous once again, and the demand variables become endogenous. Thus, the shares of each component in the petroleum–biofuel mix and biofuel categories change in response to the mandated annual percentage changes under the RFS2 as shown in **Table 2**, even without changes in relative prices. However, the final model solution represents the composite effects of these nonprice shifts in shares along with changes in relative prices.

We simulated a main scenario and two alternative cases to evaluate the national/global economic effects of the biofuel targets under the RFS2 policy. The particulars of each of the three simulation scenarios are discussed below:

- Case 1 closely follows the allocation to each category of biofuels under the full RFS2 policy by simulating the percentage changes given in Table 2 from 2002 to 2022. The values for 2001 are based on actual data;
- Case 2 simulates the percentage increases in biofuel mandates shown in Table 2 from 2002 to 2014. Under the RFS2, increases in conventional biofuel mandates taper off after 2014 and advanced biofuel production begins to increase rapidly. The RFS2 calls for the total use of biofuels in the USA to reach 17 billion gallons in 2014. Most of this consumption will be conventional biofuels (mainly corn ethanol; 14.5 billion gallons) with the rest consisting of 1 billion gallons of biodiesel, 0.5 billion gallons of cellulosic and 1 billion gallons of other advanced biofuels. This scenario serves as a basis for evaluating the potential incremental benefits of the advanced biofuel mandates after 2014 under Cases 1 and 3;
- Case 3 is another variant of Case 1, which evaluates the implications of allowing imports to meet a larger share of the requirements for advanced ethanol after 2014. Specifically, imports of biofuels are approximately 11 billion gallons in 2030 under this scenario, compared with 4 billion gallons under Case 1; thus, a little more than half of the advanced biofuel targets are met by imports under this scenario compared with only a quarter under Case 1.

Table 2. Annual percentage changes in biofuel demand by category under the RFS2.

Year	Corn ethanol	Cellulosic ethanol	Other advanced ethanol	Biodiesel
Baseline (billion gallons)				
2001	1.74	0.04	0.15	0.01
Percentage changes				
2002	19.10	0.01	25.97	22.24
2003	36.32	0.01	23.34	35.53
2004	25.70	0.01	27.03	96.39
2005	14.26	0.01	33.33	225.34
2006	35.05	0.01	25.00	175.85
2007	25.63	0.01	20.00	95.59
2008	40.62	0.01	16.67	38.06
2009	13.98	0.01	14.29	-25.35
2010	19.50	33.33	10.00	18.85
2011	0.31	16.67	2.27	33.33
2012	2.80	42.86	5.56	42.00
2013	1.47	150.00	3.16	0.00
2014	4.35	100.00	2.04	0.00
2015	4.17	200.00	50.00	0.00
2016	0.00	183.33	33.33	0.00
2017	0.00	29.41	25.00	0.00
2018	0.00	27.27	20.00	0.00
2019	0.00	21.43	16.67	0.00
2020	0.00	23.53	15.00	0.00
2021	0.00	28.57	10.00	0.00
2022	0.00	18.52	5.00	0.00

Economic effects of the full RFS2 biofuel policy in the USA: Case 1 simulation results

Production & import of biofuels in the USA

Figure 7 depicts the production of the different types of biofuels and imports under Case 1. In line with the percentage changes in Table 2 and the RFS2 policy, biodiesel production reached approximately 1 billion gallons by 2012 and corn ethanol production reached 15 billion gallons by 2015. Cellulosic ethanol production reached a level of only 0.5 billion gallons by 2014 but increased rapidly to approximately 16 billion gallons by 2022, which includes 8.4 billion gallons from the biochemical process and 7.6 billion gallons from the thermochemical process. The almost equal split of cellulosic biofuel production between the two processes reflects their close unit costs of production, as shown in Table 1. Sugarcane ethanol production in the USA remained low, as expected, whereas its import increased to approximately 4 billion gallons by 2022, which is close to the minimum requirement for other advanced biofuels (apart from biodiesel and cellulosic biofuels) under the RFS2.

Changes in global agricultural & energy prices

The global economic effects of biofuel policy are driven mainly by the response of prices in the two commodity markets – agriculture and energy – that are most directly affected. The magnitudes and signs of these price changes reflect the balance between supply and demand pressures in each market. Figure 8 illustrates changes in global prices in Case 1 relative to the baseline. As expected, fossil energy prices, particularly oil, declined as biofuels replace increasing portions of liquid fuel use in the USA. The reduction in oil prices accelerated from -3% in 2015 to approximately -7% in 2022. In contrast, the increase in the price of corn ethanol relative to the baseline, approximately 6% in 2010, remained relatively constant throughout the rest of the simulation period. Cellulosic ethanol prices increased by approximately 2% in 2010 and then stayed largely flat until 2022, when they began to decline. The price changes in Figure 8, including those for fossil fuels, are consistent with the different phases of the RFS2 policy: the phase-out of increases in conventional biofuel mandates between 2010 and 2015, rapid increases in advanced biofuel use after 2014, and the post-2022 constant level of biofuel use.

The bottom portion of Figure 8 shows that increases in food commodity prices under the RFS2 policy were less than 1% throughout the period from 2002 to 2030.

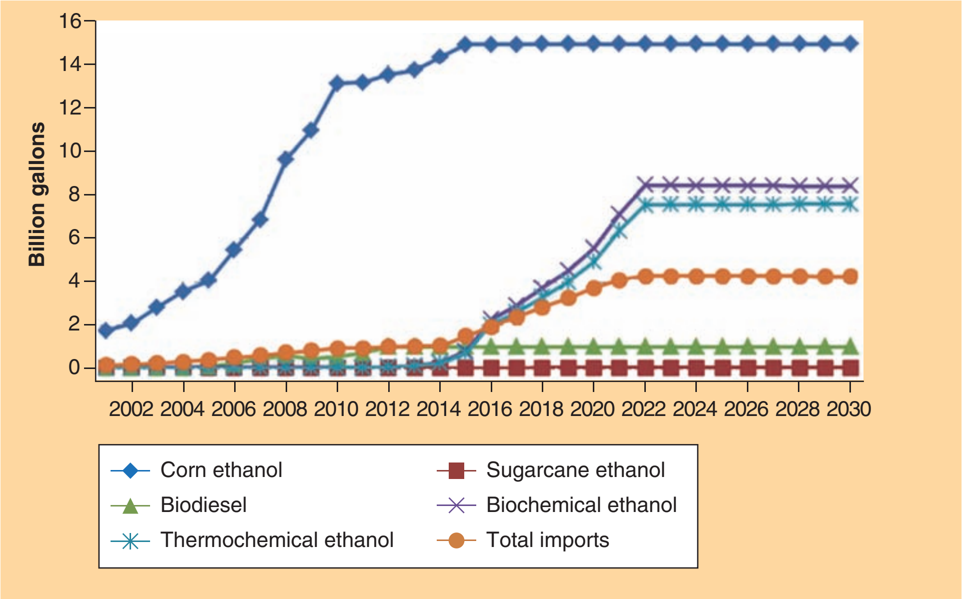

Figure 7. Production and import of biofuels in the USA under Case 1.

the USA do not reflect large volumes but rather a change relative to the low levels of exports in the baseline simulation. In the ROW, the export of oil declined by 2–3% in all years. Exports of natural gas declined in both the USA and ROW, whereas coal exports declined in the USA and increased in the ROW. The increase in coal production and exports in the ROW suggests that biofuel policy could induce potential changes in the global composition of energy use. In this case, some of the savings from reduction in oil prices were spent in purchasing additional fossil fuels, which led to a slight increase in the use of coal that reflects its large share in the global electricity generation fuel mix.

Coarse grains, which is the feedstock for conventional biofuels in the USA, had the highest price increase followed by oilseeds and other grains. These prices showed a declining trend between 2015 and 2022, reflecting the RFS2 cap on conventional biofuels after 2015. Along with the fact that most of the advanced biofuels were produced from residues after 2015, the end of increases in conventional biofuel production relieved the pressure on land use and, consequently, agricultural commodity prices. The subsequent recovery in prices after 2022 is similarly related to the end of all increases in biofuel mandates under the RFS2 after that year. However, this latter effect is mostly on the demand, rather than supply, side. The slight recovery in oil prices after 2022 increased the revenues earned by oil exporters, producing a slight recovery in demand and prices for agricultural commodities.

Changes in production & exports of energy commodities

Biofuel policy in the USA is aimed at reducing the dependence of the economy on imports of oil. **Table 3** shows that the production of crude oil and natural gas declined slightly in the USA, but decreased more significantly in the rest of the world (ROW). In contrast, coal production increased by 0.1–0.6% in the USA and the ROW. The reason for the smaller decline in oil production in the USA is explained by the results for oil exports, which showed increases of 18, 54 and 32% in 2015, 2022 and 2030, respectively. Thus, as biofuels replaced oil in the USA, more of the oil production was exported, although at slightly lower prices, as seen in **Figure 8**. The high percentage increases in oil exports by

Changes in production & exports of agricultural commodities

In addition to energy markets, biofuel policy has direct impacts on agricultural markets. The increase in use of corn for ethanol production in the USA is reflected in **Table 3**. Coarse grain production (which includes corn in the model) in the USA increased by almost 17% when the maximum target for conventional ethanol was reached in 2015. Subsequent increases in coarse grain production were smaller, at 13% in 2022 and 12% in 2030. **Table 3** also shows that the production of oilseeds in the USA increased by 4% in 2015 and by smaller amounts in 2022 and 2030. Increases in oilseeds production are partly explained by the biodiesel targets under the RFS2. The production of other agricultural commodities in the USA declined slightly in 2015 and 2022, except for other grain production, which declined by approximately 3% in all three years.

Coarse grain production in the ROW declined in all three years, as shown in **Table 3**, but by less than 0.3%. In contrast, the production of oilseeds increased by 0.3–0.9%. Except for cattle/ruminants, the production of agricultural commodities in the ROW declined by less than 1% in 2015 but recovered by 2030 as in the USA; cattle/ruminants production fell by 0.2–0.3%. The global pattern of net changes in agricultural production was similar to that of the USA, but with different magnitudes that reflect the shares of different regions in each year.

Agricultural commodity exports by the USA, except for forestry and coarse grains, declined by less than 5% in all years. Exports of forestry declined by approximately 8% in 2030, whereas that for coarse grains

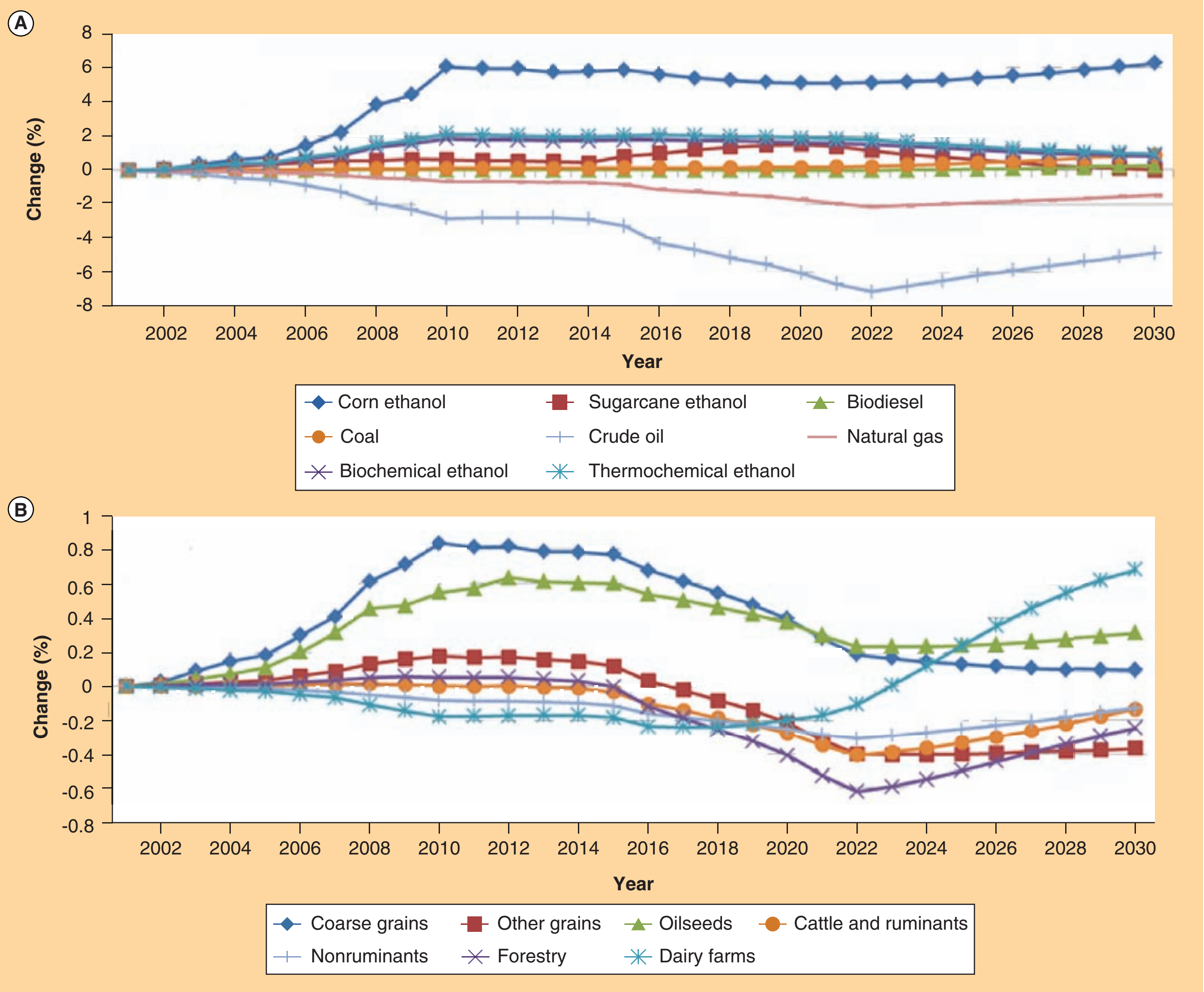

Figure 8. Changes in average global prices under Case 1. (A) Global commodities and **(B)** agricultural commodities.

declined by almost 5% in all years. Exports of most agricultural commodities by the ROW increased to offset the reduction in US exports, but there were sizable decreases in some cases. Net changes in global exports for most agricultural commodities and years were negative. Coupled with the production changes in **Table 3**, this implies that the ROW responded to the slight decline in exports by the USA in several ways. The small magnitude of production changes and presence of both increases and decreases suggest that the primary response was to change the mix of agricultural commodities production rather than expand production. As a result, exports of coarse grains and oilseeds by the ROW, which have the highest price increases among agricultural commodities in **Figure 8**, increased in all years. In contrast, most of the increases in the production of other commodities, such as other grains, were retained for domestic consumption.

Changes in agricultural land use

Agricultural land use under Case 1 increased in some regions but decreased in others, leading to a slight reduction in global land use for agriculture (**Figure 9**). In 2022, global land use for agriculture fell by approximately 7 million ha, or 0.14%. Most of the increases in agricultural land use were in the USA, as expected from the increase in production of coarse grains and oilseeds. Decreases in agricultural land use were concentrated in two main regions: the Middle East/Africa and other regions. These two regions have the characteristics of being either fossil fuel export dependent and/or agricultural import dependent. The oil export-dependent

Table 3. Percent changes in the production and exports of commodities under Case 1.

Commodity	2015			2022			2030		
	USA	ROW	Global	USA	ROW	Global	USA	ROW	Global
Production of energy commodities (%)									
Crude oil	-0.02	-0.86	-0.81	-0.04	-1.77	-1.67	-0.03	-1.19	-1.13
Natural gas	-0.09	-0.44	-0.38	-0.20	-1.06	-0.95	0.00	-0.92	-0.83
Coal	0.15	0.08	0.10	0.26	0.28	0.28	0.50	0.59	0.58
Export of energy commodities (%)									
Crude oil	18.26	-1.65	-1.64	54.93	-3.25	-3.24	31.71	-1.77	-1.77
Natural gas	-0.62	-0.37	-0.37	-0.67	-0.92	-0.91	-4.05	-0.67	-0.69
Coal	-4.09	0.39	0.21	-8.19	0.79	0.58	-16.34	1.22	1.01
Production of agricultural commodities (%)									
Coarse grains	16.59	-0.07	2.43	13.44	-0.27	1.45	11.57	-0.16	1.00
Other grains	-2.41	-0.02	-0.09	-2.76	0.09	0.02	-1.74	0.28	0.24
Oilseeds	4.04	0.32	0.81	2.42	0.73	0.92	1.70	0.94	1.01
Sugarcane	-0.88	0.21	0.16	-0.31	0.75	0.71	0.44	0.81	0.80
Forestry	-1.44	-0.08	-0.21	-0.75	-0.08	-0.13	0.18	0.12	0.13
Dairy farms	-0.32	-0.06	-0.09	0.37	0.08	0.10	1.36	0.38	0.45
Cattle/ruminants	-0.72	-0.18	-0.27	-0.56	-0.43	-0.45	0.15	-0.31	-0.26
Nonruminants	-0.13	-0.05	-0.06	-0.01	0.05	0.05	1.04	0.24	0.26
Export of agricultural commodities (%)									
Coarse grains	-4.69	0.97	-1.28	-5.61	0.60	-1.74	-4.52	0.38	-1.26
Other grains	-3.48	-0.21	-0.90	-4.38	-1.53	-2.08	-3.19	-1.82	-2.04
Oilseeds	-3.21	1.41	-0.40	-3.83	1.65	-0.53	-3.42	1.27	-0.50
Sugarcane	-7.81	0.10	-0.07	-8.11	-0.26	-0.37	-6.72	-0.95	-0.97
Forestry	-5.87	0.70	0.02	-7.58	1.43	0.69	-8.30	1.25	0.70
Dairy farms	-4.03	0.12	0.11	-6.17	-1.60	-1.61	-5.75	-4.08	-4.09
Cattle/ruminants	-4.15	0.13	-0.43	-7.53	-0.98	-1.87	-7.49	-1.32	-2.17
Nonruminants	-1.17	0.19	-0.08	-2.71	0.49	-0.13	-1.54	0.05	-0.21

ROW: Rest of the world.

economies in particular lose revenues due to reductions in the demand and prices of fossil fuels under biofuel policy. The consistent decline in production of cattle/ruminants in the ROW suggests that most of the reductions in agricultural land use in Figure 9 are in pasture. Due to the low pasture productivity and extensive area used for livestock production in many developing economies, small changes in livestock production could lead to significant land use changes in these regions. This is borne out by the bottom portion of Figure 9, which presents the agricultural land use change in percentages relative to the baseline. The maximum percentage reduction in agricultural land use in the Middle East/Africa region is approximately -0.5%, which is comparable in magnitude to the maximum increase in the USA at 0.4%. Net global agricultural land use thus declined slightly.

Changes in regional GDP & labor use

The net economic implications of biofuel policy can be summarized by changes in the regional GDP (RGDP). Figure 10 shows that changes in the size of global GDP under Case 1 were small until 2012, but turned positive with an increase of 0.5% by 2030. The RGDP effects vary significantly across regions, reflecting the interaction of price changes and the role of the different regions in the world market. The change in the RGDP was small for most regions until 2012, except Canada, Russia and the Middle East/Africa. The RGDP change was positive for Canada but negative for the latter two regions. Interestingly, the impacts on the USA were also near zero until 2012. This is because the benefits to the USA from the reduction in oil prices were partly offset by reduced oil revenues, as the USA is the third largest oil producer in the world. Similarly, the USA obtains higher export prices for grains under the biofuel mandate, but also supplies a portion of its fuel consumption (i.e., biofuels) at the higher cost of the corn feedstock, in addition to the slightly higher cost for food and feed uses of grains and slight reductions in agricultural exports. The observed positive effect on the RGDP for Canada reflects its role as an oil and grains exporter, selling oil to the ROW at a slightly lower price but exporting its grains at a higher price, without the cost of biofuel mandates. In addition, Canada supplied some ethanol to the USA under the RFS2 mandates. Thus, despite the similarity of the commodity export profiles for Russia and Canada, and their roles as large exporters of oil, the former is more dependent on fossil fuel exports than the latter. The Middle East/Africa economy is oil export dependent and a large supplier of oil, but also a net importer of grains. Thus, the terms of trade effects on this region, in the oil and corn markets, are both negative leading to reductions in the RGDP in Figure 10A.

Beyond 2012, the change in the RGDP for the USA turned positive and increased steadily, reaching an increase of approximately 2% by 2030 relative to the baseline. The change in the RGDP for India was similar to that for the USA, whereas the increase for Canada flattened out after 2022. The results show that the RGDP effects in a number of the remaining regions were small, but positive. In addition to the Middle East/Africa and Russia regions, with significant decreases in their RGDP before 2012, the effects on Brazil and Japan also became more negative after 2015. The changes in RGDP after 2015 are related to the price changes in Figure 8. The decline in agricultural prices after that year benefited agricultural commodities importers, but had the opposite effect on major exporters, such as Brazil and the USA. However, oil prices also recovered after 2015, benefiting oil exporters and hurting importers, such as Japan. The balance of these oil and agricultural market effects on the USA is small, but a predominant contribution from residue-based cellulosic feedstock for ethanol production after 2015 provided additional benefits without additional land requirements. Thus, the net benefits to the USA continued to increase through 2030. In the case of Russia and the Middle East/Africa regions, declines in the RGDP between 2015 and 2022 represent the oil market effects of the advanced biofuel mandates. After 2022, the slight recovery in global oil prices seen in Figure 8 allowed the RGDP effects in these two regions to flatten out.

The employment effect of biofuel policy is another measure that is of interest to policymakers. Figure 10B shows the percentage changes in labor use. The pattern

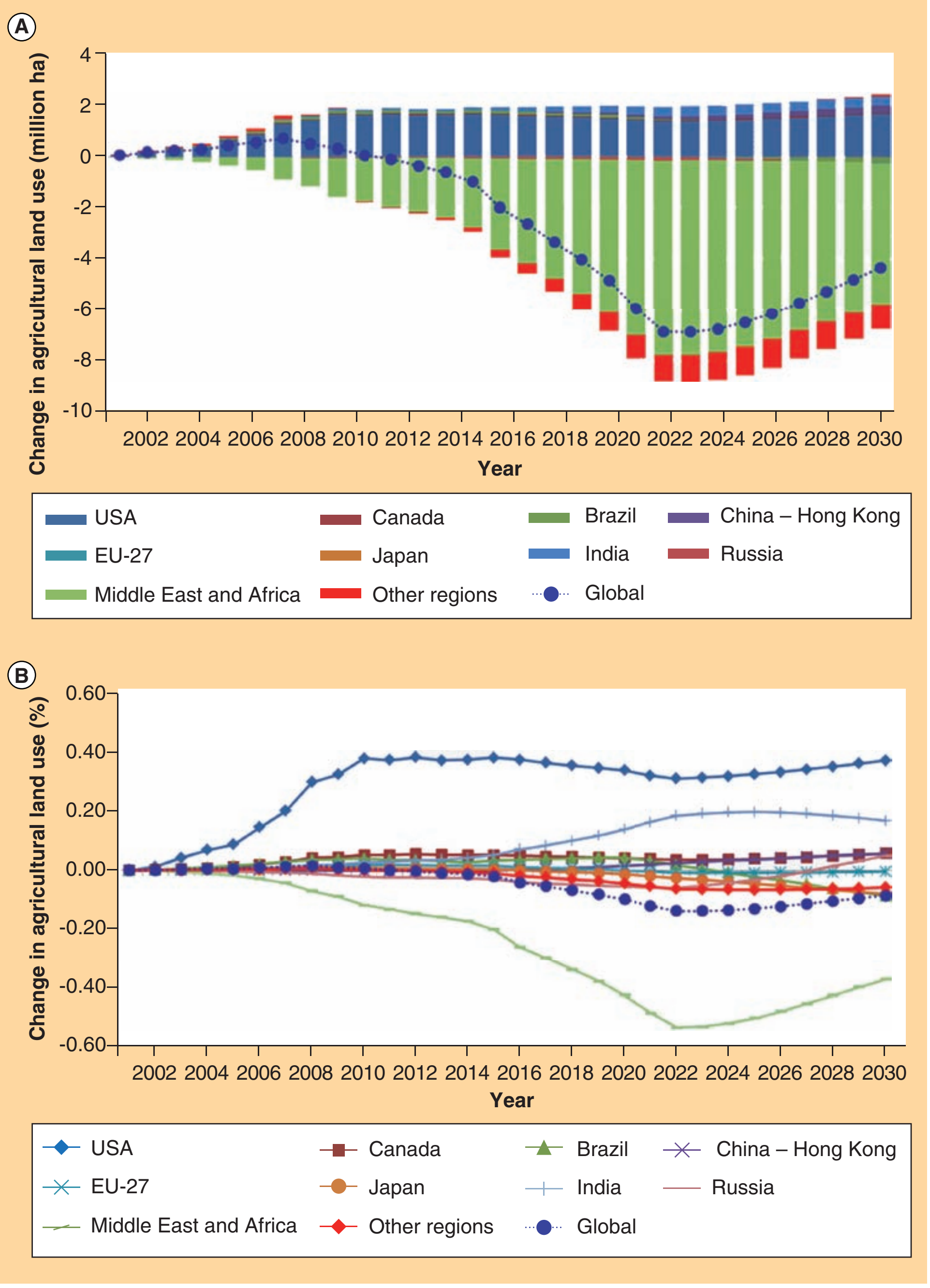

Figure 9. Changes in global agricultural land use by region under Case 1. (A) Million ha and **(B)** percentage change relative to the baseline.
Please see color figure at www.future-science.com/doi/full/10.4155/BFS.12.60.

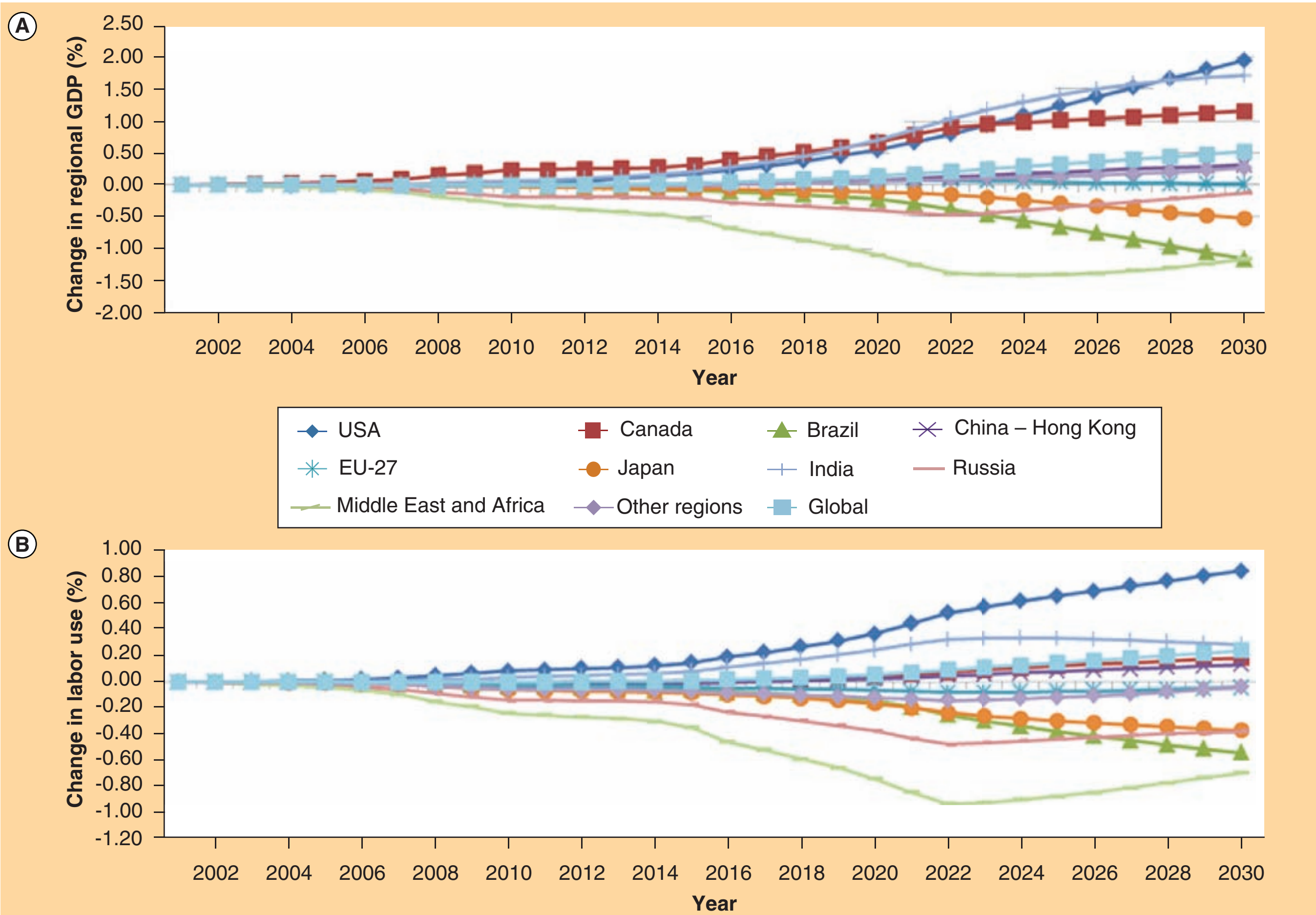

Figure 10. Changes in regional economic variables in Case 1. (A) GDP and **(B)** labor use.
GDP: Gross domestic product.

of labor use changes is in general agreement with the RGDP implications, but smaller in magnitudes. This reflects the low wage rate elasticity of labor supply in the model. The net global increase in labor use was approximately 0.2% in 2030.

▪ Incremental economic effects of the advanced biofuel targets

Although increases in the RFS2 mandates from 2015 to 2022 consist mainly of advanced biofuels, the estimated economic effects under Case 1 include conventional and advanced biofuels. We can estimate the incremental benefits of advanced biofuels by subtracting the benefits of the RFS2 mandates from 2001 to 2014 (which are primarily conventional biofuels) from those for the full RFS2 case. Case 2 evaluates a hypothetical scenario in which the RFS2 mandates are implemented only from 2001 to 2014. This allows us to decompose the economic effects in Case 1 to estimate the potential incremental benefits of the transition to advanced biofuels in the USA. Table 4 provides a summary of the economic effects under Case 2 (conventional biofuels) and the estimated incremental contribution from advanced biofuels in 2022.

The incremental change in US GDP due to advanced biofuels was similar to the contribution from conventional biofuels with a value of 0.41% in 2022. It was small but positive in the ROW, which nevertheless contrasts with the small negative effect under Case 2. The signs of labor use changes in both the USA and the ROW were consistent for conventional and advanced biofuels. However, the magnitudes of increments due to advanced biofuels were approximately double those for conventional biofuels in both regions. As expected from the use of residues to produce advanced biofuels in the USA, its agricultural land use effects were smaller than for conventional biofuels. The incremental change in agricultural land use, although positive, was less than 10% of the estimate under Case 2. Similarly, the decrease in agricultural land use in the ROW was small, but doubled in magnitude under advanced biofuels relative to Case 2.

Table 4. Decomposition of the estimated economic effects of the RFS2 into contributions from conventional and advanced biofuels in 2022.

Commodity	Conventional biofuels (%)			Incremental effect of advanced biofuels (%)					
	Case 2			Case 1 minus Case 2			Case 3 minus Case 2		
	USA	ROW	Global	USA	ROW	Global	USA	ROW	Global
Gross domestic product, labor demand & agricultural land use									
Gross domestic product	0.39	-0.02	0.08	0.41	0.04	0.13	0.16	0.04	0.07
Labor demand	0.17	-0.04	0.03	0.36	-0.10	0.06	0.14	-0.05	0.03
Agricultural land use	0.29	-0.02	-0.02	0.02	-0.04	-0.12	0.05	-0.01	-0.03
Production of energy commodities									
Crude oil	-0.01	-0.51	-0.48	-0.03	-1.26	-1.19	-0.02	-0.62	-0.58
Natural gas	-0.02	-0.39	-0.34	-0.18	-0.67	-0.61	-0.09	-0.34	-0.30
Coal	0.18	0.11	0.12	0.08	0.17	0.16	0.04	0.08	0.08
Export of energy commodities									
Crude oil	10.36	-0.83	-0.83	44.57	-2.42	-2.41	19.75	-1.22	-1.22
Natural gas	-1.14	-0.28	-0.29	0.47	-0.64	-0.62	0.24	-0.33	-0.33
Coal	-5.59	0.36	0.22	-2.60	0.43	0.36	-1.10	0.21	0.18
Production of agricultural commodities									
Coarse grains	13.27	-0.12	13.44	0.17	-0.15	-0.11	0.41	-0.08	-0.02
Other grains	-1.77	0.01	-2.76	-0.99	0.08	0.05	-0.60	0.04	0.03
Oilseeds	3.26	0.31	2.42	-0.84	0.42	0.29	-0.27	0.19	0.15
Sugarcane	-0.55	0.13	-0.31	0.24	0.62	0.60	0.01	1.62	1.56
Forestry	-0.99	-0.02	-0.75	0.24	-0.06	-0.04	0.00	-0.04	-0.05
Dairy farms	-0.05	0.00	0.37	0.42	0.08	0.10	0.13	0.04	0.05
Cattle and ruminants	-0.43	-0.15	-0.56	-0.13	-0.28	-0.26	-0.11	-0.15	-0.15
Nonruminants	0.11	-0.01	-0.01	-0.12	0.06	0.06	-0.02	0.02	0.02
Export of agricultural commodities									
Coarse grains	-3.57	0.69	-0.91	-2.04	-0.09	-0.83	-1.03	-0.15	-0.48
Other grains	-2.55	-0.38	-0.81	-1.83	-1.15	-1.27	-1.08	-0.49	-0.60
Oilseeds	-2.48	1.08	-0.34	-1.35	0.57	-0.19	-0.39	-0.10	-0.21
Sugarcane	-5.97	-0.05	-0.13	-2.14	-0.21	-0.24	-1.27	-0.11	-0.12
Forestry	-4.89	0.58	0.12	-2.69	0.85	0.57	-1.61	0.41	0.25
Dairy farms	-3.10	-0.45	-0.45	-3.07	-1.15	-1.16	-1.51	-0.56	-0.56
Cattle and ruminants	-3.45	-0.11	-0.57	-4.08	-0.87	-1.30	-2.11	-0.42	-0.65
Nonruminants	-0.63	0.07	-0.07	-2.08	0.42	-0.06	-0.83	0.16	-0.03

ROW: Rest of the world.

The incremental energy market effects of the advanced biofuels in 2022 were generally larger in magnitude but have the same signs as for conventional biofuels. Thus, the reductions in oil production in the USA and the ROW due to advanced biofuels in 2022 were approximately twice those under Case 2. The increases in coal production were approximately half in the USA and double in the ROW, as under Case 2. The change in export of oil by the USA from the effects of advanced biofuels was approximately four-times those for Case 2. In addition, natural gas exports increased, rather than decreased, and the decrease in export of coal was approximately half of that in Case 2. Given the smaller change in total agricultural land use, the corresponding incremental effects of advanced biofuels on agricultural production/exports in the USA and ROW were also much smaller than under Case 2. The increase in coarse grains production in the USA was only approximately 0.2%, or just over one-tenth of the increase in Case 2. Thus, the net global effects of the advanced portion of the RFS2 on agricultural production are slightly positive relative to conventional fuels. Changes in agricultural exports by the USA were negative as in the case for conventional biofuels, but were smaller in magnitude. The sign of changes in agricultural exports were also consistent between the two cases for the ROW, but the magnitudes were lower for some commodities and higher for others under advanced biofuels relative to Case 2.

Incremental economic effects of advanced biofuels with higher imports

The slower development of advanced biofuels in the USA has raised concerns about a shortfall in the domestic capacity to meet the targets under the RFS2. A potential option for dealing with this issue, while retaining the total RFS2 targets, is to increase the imports of advanced biofuels. Sugarcane ethanol, which is mainly produced in Brazil, is the other major advanced biofuel currently represented in the GTAP-DEPS model. We evaluate the potential implications of this alternative on the incremental economic effects of the advanced biofuel targets. Specifically, Case 3 increased the portion of advanced biofuel targets met through imports to half of the total under the RFS2.

The incremental economic effects of this case relative to conventional biofuels (Case 2) are shown in Table 4 for 2022. Changes in the incremental effects of advanced biofuels on the RGDP, labor use and agricultural land use were significant. Specifically, the change in GDP in the USA dropped to 0.16% with the increase in imports compared with 0.41% without, but the result for the ROW remained at 0.04%. As a result, the incremental global GDP benefits of advanced biofuels dropped by half. The incremental change in labor use in the USA also declined to 0.14% instead of 0.36%, but the change in the ROW improved from -0.1 to -0.05%. The incremental change in global agricultural land use under this scenario was approximately -0.03%, which is almost the same as for conventional biofuels under Case 2. However, the regional distribution of this incremental land use change was different from Case 2, with a change of only +0.05% in the USA and -0.01% in the ROW, compared with +0.29 and -0.02% under Case 2, respectively. The shifts in GDP benefits, labor use and land use towards the ROW in this scenario are expected from increases in sugarcane ethanol exports to the USA. The incremental change in production/exports of energy and agricultural commodities are consistent with the aggregate results.

Summary & conclusion

As the production of conventional biofuels approaches its target, the transition to advanced biofuels becomes important to meeting the objectives of the RFS2 policy. These objectives include reducing the imports of oil and life cycle emissions of GHG from liquid transportation fuels. Therefore, it is necessary to understand the potential costs and benefits of the advanced biofuel targets under the RFS2 as a guide for decision-making during this transition process. The global context of the energy issues that motivate biofuel policies and potential interactions between the USA and the global economy require that such evaluations be conducted within a global framework.

This study provides an evaluation of the global economic effects of the RFS2 policy and estimates the potential contribution of the advanced biofuel requirements. We employ a dynamic model of the global economy, which allows for an explicit simulation of the biofuel mandates specified under the RFS2. Previous evaluations of the economic effects of the RFS2 have generally been performed within a static framework in which oil prices are exogenously specified. The model used in this study accounts for the endogenous response of global energy and agricultural markets, which are crucial ingredients in estimating the global implications of biofuel policy.

The representation of biofuel policy in the model closely follows the design and implementation of the RFS2 as a share mandate; therefore, the estimated economic effects are representative of the expected implications of the policy. The global economic effects of the USA biofuel targets, as measured by the GDP, are found to be positive in 2022. Specifically, under Case 1 (full RFS2 mandates through 2022) the size of the global GDP increased by 0.21% in 2022. The USA GDP increased by 0.8% in 2022 under Case 1, whereas the ROW GDP increased by only 0.02%. Thus, this study found that the economic effects of the USA biofuel targets on the ROW are largely neutral.

Consumers of oil benefited from the lower prices induced by US biofuel policy, whereas exporters lost revenue from decreases in both demand and price. Previous studies have also noted the counteracting effects on incomes from changes in fossil energy and agricultural prices under biofuel policy [11]. The employment implications of the mandates, measured by percentage changes in labor use, follow the same pattern as the GDP effects. The pattern of economic effects fluctuated over time; in particular, the net effects of biofuel policy on US GDP were near zero until 2012, when increases in conventional biofuels production began to slow down. At that point, the cumulative benefits of the reduction in oil prices overcame the economy-wide cost of additional conventional biofuels, leading to a positive effect on the economy.

Results also suggest that the potential economic benefits of the advanced biofuel targets are positive in the USA and largely neutral in the ROW. Incremental benefits of the advanced biofuel targets were calculated by subtracting the estimated economic effects under Case 2 (conventional biofuels) from the results for full RFS2 Cases 1 and 3. In the USA, incremental contributions to the GDP from advanced biofuels were 0.41 and 0.16% under Cases 1 and 3 relative to Case 2, respectively. We also estimated a small positive contribution to the ROW GDP from the advanced biofuel targets at 0.04% under Cases 1 and 3, compared with small reduction under conventional biofuels (Case 2).

The increases in GDP from the advanced biofuel targets reflect trade-offs among higher costs of production, additional reductions in oil use and lower impacts on food markets relative to conventional biofuels. The data underlying our simulations, and the baseline output of biofuels in Table 1, imply initial productions costs in 2001 (in 2001 dollars) of approximately $1.6, $2.3, $1.4 and $0.9/gallon for corn ethanol, cellulosic ethanol, biodiesel and sugarcane ethanol, respectively. Thus, the higher cost of cellulosic biofuels is somewhat compensated by the lower cost sugarcane ethanol portion of the advanced biofuel targets. In addition, cellulosic biofuels, which are mainly produced from residues, offer additional benefits relative to conventional biofuels. On the one hand, use of residues for ethanol production reduced the competition for agricultural land and relieved the pressure on global agricultural prices after 2014. On the other hand, increases in the production of advanced biofuels in the USA accelerated the effects of biofuels on global energy markets.

Under Case 1, which matches the evolution of biofuel mandates in the RFS2 closely, the decrease in the global oil price relative to the baseline was -7% in 2022 compared with -3% in 2015. The corresponding change in the global production of crude oil was -1.67% in 2022 and -0.81% in 2015. A comparison of the global change in oil production in 2022 under Case 1 to that for Case 2 relative to the baseline shows that the incremental effect of advanced biofuels was -1.19%. In Case 3 we evaluated the implications of higher imports of advanced biofuels on their incremental benefits. The results show that despite the lower costs of sugarcane ethanol, a greater reliance on imports could reduce the benefits of advanced biofuels significantly. This is because imported biofuels displace domestic production and, as with oil, increase payments for fuels to the ROW. Imported biofuels also replace a portion of the cellulosic biofuels produced mainly from residues in the USA with land using sugarcane ethanol, with potential impacts on food markets.

One additional finding from this study is that reductions in agricultural land use in oil export-dependent economies more than offset increases elsewhere. This latter result is tied to the low productivity and extensive area used for livestock production in developing economies. Despite the copious research into the land use implications of biofuel policy, insights into the local-level effects remain limited.

Finally, the current study examined the economic effects of advanced biofuels based on the estimated costs of mature conversion technologies and the assumption that infrastructural barriers to advanced biofuel use are resolved. These assumptions are common to most studies of the economic effects of biofuels. Thus, the estimated benefits in this study represent the potential national/global economic effects against which the implementation and infrastructural costs can be evaluated. The recent shift in focus of biofuel production technology research in the USA to include drop-in biofuels suggests another important area for future research. It would be important to compare the costs and benefits of drop-in biofuel technologies to those of cellulosic ethanol, accounting for differences in their infrastructure and vehicle requirements. Also, the simulations in this study do not account for efficiency improvements in biofuel production over the last decade. In addition, the current simulations assume that global energy markets remain tight throughout the simulation period. Alternative simulations would be useful to examine the impacts of future developments in fossil fuel markets. These and other refinements are reserved for future research.

Future perspective

Global biofuel production and use has increased strongly since 2001. Limited increases in the global capacity to produce oil, coupled with a strong growth in demand, led to a tight energy market that raised concerns about energy security. Biofuels are currently the closest commercially available alternatives to fossil-based liquid transportation fuels. Although public policies to support the use of biofuels have been in place in the USA since the 1970s, its use remained small until recent renewable fuel standards and other policies were enacted. The US RFS of 2005 set a target of 7.5 billion gallons by 2012. This was expanded by the RFS portion of the EISA of 2007, often referred to as the RFS2, to 36 billion gallons of biofuel to be used in the USA by 2022. Up to 15 billion gallons of the RFS2 target are to be derived from conventional biofuels and 21 billion gallons from advanced biofuels. By 2011, the production of conventional biofuels, mainly corn ethanol, was almost 14 billion gallons, whereas the production of advanced biofuels had yet to take off. There are several cellulosic biofuel plants under construction, and it is projected that capacity for this group of advanced biofuels will reach 640 million gallons by 2014.

One of the major impediments to the greater use of biofuels in the USA is the incompatibility of the current liquid fuel infrastructure and vehicle fleet with a gasoline–ethanol mixture containing high levels of ethanol. This has motivated a new effort to produce drop-in biofuels that can be mixed in flexible quantities with petroleum fuels or used directly in gasoline and diesel engines. There are many potential options for meeting this objective, but the technologies and costs are still under investigation. The US National Advanced Biofuel Consortium recently selected two of the six most viable technology pathways for further development: fermentation of lignocellulosic sugars and catalysis of lignocellulosic sugars. These technologies, along with two others, would receive funding to "further develop the selected technologies to a pilot-ready state over 2 years" [107]. Thus, their potential as viable alternatives to cellulosic ethanol will become clearer over the next 2–5 years. Meanwhile, the use of ethanol in the US vehicle fleet may increase over the next 5 years if global oil market remains tight. In addition, the US EPA has granted blenders the option to include up to 15% ethanol in gasoline sold in the USA for use in vehicle model years 2001 and up [108]. This would further increase the potential to replace gasoline with biofuels in the USA over the next 5 years, as the required pump infrastructure and labeling adjustments are put in place by retailers.

Financial & competing interests disclosure

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No writing assistance was utilized in the production of this manuscript.

Executive summary

Background

- The transition to advanced biofuels is crucial to sustain the momentum in developing biofuels as alternatives to fossil-based liquid fuels.

Method & data

- The study employs an adaptive-expectations dynamic general equilibrium model of the global economy to evaluate the global economic effects of the RFS2 policy and the potential contribution from advanced biofuels.
- The model incorporates many enhancements to adequately capture the costs and economy-wide benefits of biofuels, and reveals important time patterns of those effects.

Simulations of biofuel scenarios

- Results suggest that the net global economic effects of the RFS2 policy are positive with an increase of 0.8% in US gross domestic product (GDP) in 2022, but with a largely neutral effect on the rest of world GDP.
- The contributions of advanced biofuels to the change in GDP in 2022 were estimated at 0.41% in the USA, and 0.04% in the rest of the world.

Summary & conclusion

- The economic benefits of conventional and advanced biofuels are primarily from their effects in reducing the imports and use of oil.
- The higher costs of advanced biofuels are offset by smaller impacts on food markets relative to conventional biofuels.
- Increasing imports to meet the advanced biofuel targets in the USA could reduce the economic benefits.

References

Papers of special note have been highlighted as:

■ of interest

■■ of considerable interest

1 US Government. *The Energy Independence and Security Act of 2007 (H.R.6)*. US Government, Washington, DC, USA (2007).

2 Verick S, Islam I. *The Great Recession of 2008–2009: Causes, Consequences and Policy Responses. Discussion Paper Series, IZA DP No. 4934*. Institute for the Study of Labor, Bonn, Germany (2010).

■ **Reviews the status, uncertainties and shortcomings of existing models of land use change.**

3 Wicke B, Verweij P, van Meijl H, van Vuuren DP, Faaij APC. Indirect land use change: review of existing models and strategies for mitigation. *Biofuels* 3(1), 87–100 (2012).

■■ **One of the first assessments of the economic effects of the RFS 2 using a detailed computable general equilibrium model of the US economy.**

4 Gehlhar M, Winston A, Somwaru A. *Effects of Increased Biofuels on the US Economy in 2022. Economic Research Report 102*. Economic Research Service, US Department of Agriculture, Washington, DC, USA (2010).

5 Taheripour F, Hertel TW, Tyner WE, Beckman JF, Birur DK. Biofuels and their by-products: global economic and environmental implications. *Biomass Bioenergy* 34, 278–289 (2010).

■■ **Review of studies on the impact of biofuels on agriculture and reasons for the wide range of estimates.**

6 Zhang W, Yu E, Rozelle S, Yang J, Msangi S. *The Impact of Biofuel Growth on Agriculture: Why is the Range of Estimates So Wide? Working Paper*. Biofuels and the Poor, Washington, DC, USA (2011).

■ **Recent analysis of the RFS2 targets with a dynamic programming model of the US, incorporating different combinations of policies and technologies.**

7 Chen X, Khanna M. Food vs fuel: the effect of biofuel policies. *Am. J. Agric. Econ.* (2012) (Epub ahead of print).

■■ **Assesses the potential global effects of the implementation of biofuel mandates in several countries.**

8 Timilsina GR, Mevel S, Shrestha A. Oil price, biofuels and food supply. *Energy Policy* 39, 8089–8105 (2011).

9 Kretschmer B, Narita D, Peterson S. The economic effects of the EU biofuel target. *Energy Economics* 31, S285–S294 (2009).

10 Banse M, van Meijl H, Tabeau A, Woltjer G, Hellmann F, Verbug PH. Impact of EU biofuel policies on world agriculture and land use. *Biomass Bioenergy* 35, 2385–2390 (2011).

11 Al-Riffai P, Dimaranan B, Laborde D. *Global Trade and Environmental Impact Study of the EU Biofuels Mandate*. International Food Policy Research Institute, Washington, DC, USA (2010).

12 Yang J, Huang J, Qiu H, Rozelle S, Sombilla MA. Biofuels and the greater Mekong

subregion: assessing the impact on prices, production and trade. *Appl. Econ.* 86, S37–S46 (2009).

13 Arndt C, Msangi S, Thurlow J. Are biofuels good for African development? An analytical framework with evidence from Mozambique and Tanzania. *Biofuels* 2(2), 221–234 (2011).

14 Lashitew AA. Competition between food and biofuel production in Ethiopia: a partial equilibrium analysis. *Biofuels* 2(6), 611–627 (2012).

▪ **Application of the model used in this study to evaluate the indirect energy-use effects of biofuel production and use in the USA between 2001 and 2010.**

15 Oladosu G. Estimates of the global indirect energy-use emission impacts of USA biofuel policy. *Appl. Energy* 99, 85–96 (2012).

▪ **Discusses the efficacy of alternative biofuel policies in achieving energy, environmental and agricultural policy goals.**

16 de Gorter H, Just DR. The social costs and benefits of biofuels: the intersection of environmental, energy and agricultural policy. *Appl. Econ. Perspect.* 32(1), 4–32, (2010).

17 Hertel TW. *Global Trade Analysis: Modeling and Applications.* Cambridge University Press, Cambridge, UK (1997).

18 McDougall R, Golub A. *GTAP-E: A Revised Energy-Environmental Version of the GTAP Model. GTAP Research Memorandum No. 15.* Purdue University, West Lafayette, IN, USA (2009).

19 Liu J, Surry Y, Dimaranan B, Hertel T. CDE calibration. In: *Global Trade Assistance and Protection: GTAP 4 Data Base Documentation*. McDougall RA, Elbehri A, Truong TP (Eds). Center for Global Trade Analysis, Purdue University, West Lafayette, IN, USA (1998).

20 Ianchovichina E, McDougall R. *Theoretical Structure of Dynamic GTAP. Technical paper No. 17.* Center for Global Trade Analysis, Purdue University, West Lafayette, IN, USA (2001).

▪▪ **Study of the cellulosic feedstock supply potential and cost in the USA, accounting for sustainability constraints**

21 Perlack RD, Stokes BJ. *US Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry. ORNL/TM-2011/224.* Oak Ridge National Laboratory, Oak Ridge, TN, USA (2011).

22 Rose A, Oladosu G. Greenhouse gas reduction policy in the United States: identifying winners and losers in an expanded permit trading system, *Energy J.* 23(1), 1–18 (2002).

23 Pizer W, Burtraw D, Harrington W, Newell R, Sanchirico J. Modeling economy-wide vs sectoral climate policies using combined aggregate-sectoral models. *Energy J.* 27(3), 135–168 (2006).

24 Tao L, Aden A. The economics of current and future biofuels. *In Vitro Cell. Dev. Bio. Plant* 45, 199–217 (2009).

25 Philip S, Aden A, Jechura J, Dayton D. *Thermochemical Ethanol Via Indirect Gasification and Mixed Alcohol Synthesis of Lignocellulosic Biomass, NREL Report No: TP-510–41168.* National Renewable Energy Laboratory, Golden, CO, USA (2007).

26 Aden A, Ruth M, Ibsen K *et al. Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover. NREL Report TP-510–32438.* National Renewable Energy Laboratory, Golden, CO, USA (2002).

27 Taheripour F, Birur DK, Hertel TW, Tyner WE. *Introducing Liquid Biofuels into the GTAP Database. GTAP Research Memorandum No. 11.* Purdue University, West Lafayette, IN, USA (2007).

28 Lee H, Hertel T, Sohngen B, Ramankutty N. *Towards An Integrated Land Use Database for Assessing the Potential for Greenhouse Gas Mitigation, GTAP Resource #1900.* Global Trade Analysis Project, West Lafayette, IN, USA (2007).

29 McDougall RA, Walmsley T, Golub A, Ianchoiachina E, Itakura K. An overview of the dynamic GTAP database: the database construction and aggregation programs. In: *Global Economic Analysis: Dynamic Modeling and Application*. Ianchovichina E, Wamsley T (Eds). Cambridge University Press, Cambridge, UK (2011)

30 Walmsley TL. A baseline scenario for the dynamic GTAP model. In: *Global Economic Analysis: Dynamic Modeling and Application*. Ianchovichina E, Wamsley T (Eds). Cambridge University Press, Cambridge, UK (2011).

31 Bouët A, Dimaranan BV, Valin H. *Modeling the Global Trade and Environmental Impacts of Biofuel Policies. IFPRI Discussion Paper 01018.* International Food and Policy Research Institute, Washington, DC, USA (2010).

32 Golub A, McDougall R. Behavioral and entropy parameters of the dynamic GTAP model. In: *Global Economic Analysis: Dynamic Modeling and Application*. Ianchovichina E, Wamsley T (Eds). Cambridge University Press, Cambridge, UK (2011).

33 Tannura M, Irwin S, Good D. *Are Corn Trend Yields Increasing at a Faster Rate? MOBR 08–02, Marketing and Outlook Briefs.* University of Illinois, Urbana, IL, USA (2008).

34 Huang H, Khanna M. An econometric analysis of US crop yield and cropland acreage: implications for the impact of climate change. Presented at: *The Agricultural and Applied Economics Association, CAES, and WAEA Joint Annual Meeting.* Denver, CO, 25–27 July 2010.

▪ Websites

101 Ascencion Publishing. Advanced biofuel tracking database. www.ascension-publishing.com/BIZ/ABTDv17.xls

102 National Advanced Biofuels Consortium. Advanced biofuels processing and integration. www.nabcprojects.org/biofuels.html

103 SAGE – Center for Sustainability and the Global Environment. Maps, data, models. www.sage.wisc.edu/mapsdatamodels.html

104 World Bank. World development indicators database. http://databank.worldbank.org/databank/download/WDIandGDF_excel.zip

105 International Monetary Fund. World economic outlook database. www.imf.org/external/pubs/ft/weo/2010/02/weodata/index.aspx

106 United States Department of Agriculture. Production, supply, and distribution online. www.fas.usda.gov/psdonline

107 National Advanced Biofuels Consortium. The NABC Completes its Stage II Plans. www.nabcprojects.org/pdfs/nabc_completes_stage_ii_plans.pdf

108 US Environmental Protection Agency. E15 (a blend of gasoline and ethanol). www.epa.gov/otaq/regs/fuels/additive/e15

RENEWABLE FUELS ASSOCIATION

RENEWABLE FUEL STANDARD (RFS) FLEXIBILITY PROVISIONS

The Renewable Fuel Standard (RFS) regulation contains a number of provisions that provide both compliance flexibility for obligated parties and regulatory flexibility for the Environmental Protection Agency (EPA). These measures are intended to: 1) afford EPA the ability to administratively adjust RFS requirements on an annual basis in light of prevailing fuel market and economic conditions; and, 2) provide obligated parties the ability to comply with annual RFS requirements in the event of a shortage of renewable fuel or other market anomaly.

Obligated parties, typically refiners and importers, demonstrate that they have met or exceeded their annual RFS blending requirements by submitting RINs (Renewable Identification Numbers). In essence, RINs are serial numbers assigned to every gallon of renewable fuel. When a refiner or blender purchases a gallon of renewable fuel, they also receive the RIN. When that gallon of renewable fuel is blended with gasoline or diesel fuel and placed into commerce, the obligated party separates the RIN from the gallon. The RIN can then be submitted to EPA to demonstrate compliance, banked for compliance with future RFS requirements, or sold to other regulated parties on the open market.

COMPLIANCE FLEXIBILITY FOR OBLIGATED PARTIES

- **RIN Banking and Trading Provisions**: If an obligated party blends more renewable fuel than is required by the RFS, it can sell its surplus RINs to other obligated parties who may not have blended enough renewable fuel to meet their obligation. Alternatively, the obligated party can bank the surplus RINs for future compliance use. Further, non-obligated third parties are also allowed to buy, sell and hold RINs.

- **RIN Roll-Over Allowance**: The RFS regulations allow obligated parties to meet up to 20 percent of their current year blending obligation with RINs generated in the previous year. Thus, RINs have a two-year compliance life, adding a significant measure of flexibility to the program. This provision was intended to ensure obligated parties are able to comply with annual requirements even in the event of marketplace anomalies that may result in temporary shortages of renewable fuel.

- **Deficit Carry-Forward Provision**: If an obligated party is unable to blend the necessary quantity of renewable fuel to comply with its annual requirement, and is also unable to obtain sufficient RINs from other parties to cover the obligation, it may carry a RIN deficit into the following compliance year. There is no limitation on the size of the deficit that may be carried forward; the only requirement is that both the deficit from the previous year and the obligation for the current year be fully reconciled.

- **Small Refiner Exemptions**: EPA has historically exempted small refiners from complying with the RFS. While the blanket exemption for small refiners has expired, small refiners may still petition EPA for an exemption from RFS requirements.

- **RIN Interchangeability**: The RFS consists of several "nested standards" that require obligated parties to use quotas of certain renewable fuels, with each type of renewable fuel having its own distinctive RIN type. The "advanced biofuel" standard is nested within the overall "renewable fuel" standard. The "advanced biofuel" standard includes requirements for "cellulosic biofuel" and "biomass-based diesel." In the event of a shortage of conventional biofuel (e.g., grain-based ethanol), any "advanced biofuel" can be used to meet RFS requirements for "renewable fuel." For example, if there is a shortage of grain-based ethanol, imported sugarcane ethanol or biodiesel (both of which are classified as advanced biofuels) can be used to meet conventional renewable fuel requirements.

ADMINISTRATIVE FLEXIBILITY FOR EPA

- **Annual Renewable Volume Obligation (RVO) Percentage**: On an annual basis, EPA conducts a rulemaking to establish actual RFS blending requirements for obligated parties. Based on the statutory RFS volumetric requirements, projected gasoline and diesel consumption, and other factors, EPA establishes a percentage that represents the share of an obligated party's fuel that must be constituted by renewable fuels. Because the annual RVO is a percentage, the actual RIN obligation may be lower than the statutory volume if actual gasoline and/or diesel consumption turns out to be lower than projected at the time the RVO was established. In this way, *the RFS is sensitive to changes in gasoline and diesel demand* that occur within the course of the year.

- **Cellulosic Biofuel Waiver Provisions**: EPA has the authority to reduce the annual statutory cellulosic biofuel requirement to the projected volume available during the calendar year. EPA has done this every year since the RFS2 was promulgated. In 2012, for instance, EPA reduced the cellulosic biofuel requirement from the statutory level of 500 million gallons to just 10.45 million gallons.

- **Advanced Biofuel Standard Adjustment:** Through the annual rulemaking process, EPA may also reduce the annual advanced biofuel requirement by an amount commensurate with the cellulosic biofuel waiver.

- **Total RFS Adjustment**: EPA also has the authority to reduce the total annual RFS requirement by the amount of the cellulosic biofuel and advanced biofuel waivers.

- **Total RFS Waiver Authority**: EPA is empowered by the statute to waive any part of the RFS if the Administrator determines the program is causing "severe harm" to the economy or environment, or if there is "inadequate domestic supply." States and parties subject to RFS requirements may also petition the Administrator to consider waiving the RFS, in whole or in part, based on these criteria.

- **Future Modification of Applicable RFS Volumes:** If the Administrator waives at least 20 percent of the applicable RFS volume requirement set forth in the statute for 2 consecutive years, or at least 50 percent of such volume requirement for a single year, EPA must modify the applicable statutory volumes for 2016 and beyond.

CONCLUSION

Through various provisions allowing banking and trading of RIN credits, obligated parties have extraordinary flexibility to ensure compliance with annual RFS requirements. Additionally, EPA has tremendous latitude in administering the RFS program on a year-to-year basis. This combination of compliance and regulatory flexibility ensures obligated parties can meet RFS requirements even in the face of unusual market anomalies. Accordingly, these flexibilities render legislative reform of the RFS program unnecessary and imprudent.

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1050 K Street, NW, Suite 700,
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202 466 1495

April 29, 2013

Representative Fred Upton	Representative Henry Waxman
Chairman	Ranking Member
Committee on Energy and Commerce	Committee on Energy and Commerce
2125 Rayburn House Office Building	2125 Rayburn House Office Building
Washington, DC 20515	Washington, DC 20515

Dear Chairman Upton and Ranking Member Waxman:

Thank you for the opportunity to comment on the Committee's second white paper concerning the Renewable Fuels Standard (RFS) and its effect on the agricultural sector. Below, we provide input on three of the questions asked by the Committee.

3. Was EPA correct to deny the 2012 waiver request? Are there any lessons that can be drawn from the waiver denial?

Pursuant to section 211(o)(7)(A) of the Clean Air Act, 42 USC 7545(o)(7)(A), the Administrator may waive the mandates in whole, or in part, by reducing the national quantity of renewable fuels required, based on either a determiniation that the mandate "would severly harm the economy or the environment" or that there is inadequate domestic supply. Specifically, the Act's waiver provision states:

> The Administrator, in consultation with the Secretary of Agriculture and the Secretary of Energy, may waive the requirements of paragraph (2) in whole or in part on petition by one or more States, by any person subject to the requirements of this subsection, or by the Administrator on his own motion by reducing the national quantity of renewable fuel required under paragraph (2)—
>
> (i) based on a determination by the Administrator, after public notice and opportunity for comment, that implementation of the requirement would severely harm the economy or environment of a State, a region, or the United States; or

> (ii) based on a determination by the Administrator, after public notice and opportunity for comment, that there is an inadequate domestic supply.

There have been two separate petitions for waivers of the standards where EPA sought public comment and denied the waiver request. Both waiver petitions were based on an assertion that the mandates would severely harm the economy.

The Committee asks whether EPA was correct to deny the 2012 waiver request. Based on the facts at the time, Shell believes that EPA correctly concluded that even if they issued a waiver at that time, it is likely it would not have resulted in a reduction in ethanol use at that time. In our view, the key facts at the time were the following:

- The RFS blend wall had not yet been reached;
- The vast majority of gasoline in the United States – in excess of 90 percent -- at the time was blended with 10 percent ethanol;
- Up to the 10 percent blending level, ethanol is relied upon to provide octane;
- At the time, ethanol was economic relative to gasoline;
- Contracts and pipeline specifications make it difficult to quickly change from ethanol blends to non-ethanol blends and vice versa; and
- Every year the mandates under the RFS get larger, so even if the mandate was waived for part of 2012, obligated parties would likely continue to blend ethanol to acquire RIN credits for 2013 compliance.

Based on all of these facts, Shell advised both the EPA and the U.S. Department of Energy that even if they did issue the 2012 waiver, it would likely not reduce the amount of ethanol blended into gasoline in 2012.

In our view, the important things to understand about the 2012 waiver decision are that the facts are significantly different now that the blend wall has been reached, and even though EPA denied previous waiver requests, one should not conclude that they cannot issue future waivers. Now that the blend wall has been reached, the issuance of a waiver can alleviate some of the harmful effects of the blend wall. As a result of the blend wall, the RFS ultimately limits the supply of gasoline and diesel supply for U.S. consumption, as explained in the attached Shell one-pager. Thus, if the mandates are waived, that limitation will be lifted. Furthermore, as a result of the escalation in RIN prices, the blend wall is already having an impact on U.S. supplies of gasoline and diesel fuel by causing a reduction in imports and an increase in exports. Waiving the mandates at this point would alleviate that impact, which should have a positive impact on supplies of gasoline and diesel fuel for U.S. consumption.

EPA's issuance of waivers is not, however, sufficient to correct the deficiencies in the RFS. Clean Air Act section 211(o)(7)(C) specifies that waivers can only be issued one year at at time. There are two problems with this approach. First, because the next year's mandates under the RFS will always be larger, even if EPA issues a waiver in one year, it may not fully allieviate the RFS's adverse impacts since obligated parties will remain concerned about their obligation for the next year, and may continue to take action to reduce their obligation and maximize their RIN credit carryover to help with compliance in the following year. And, of great concern to companies like Shell that are pursuing cellulosic biofuels, yearly issuance of waivers does not provide regulatory certainty, and therefore undermines investments in cellulosic biofuels. It is far better, in Shell's view, for Congress to adopt more comprehensive solutions to the blend wall problem that will support and encourage investments in cellulosic biofuels.

7. What impact are cellulosic biofuels expected to have on rural economies as the production of such fuels ramps up?

8. Will the cellulosic biofuels provisions succeed in diversifying the RFS?

Shell would expect that cellulosic biofuels will have a positive impact on rural economies as the production of such fuels ramps up. Depending on the feedstocks used, cellulosic biofuel production could add to the benefit already realized in the midwest from the increases in corn and soybean crops as a result of corn-based ethanol and soy-based biodiesel production. However, we would also expect additional areas in the country would benefit from cellulosic biofuels. For example, several companies in the northwestern and the southern U.S. are considering or already using wood as feedstocks. This could benefit areas of the country that rely heavily on the forestry industries that have felt the impacts of the economic slow down in the housing and paper industries.

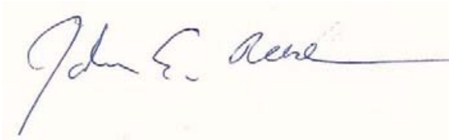
Not only do we expect feedstocks to diversify under the RFS, we also expect the types of biofuels produced to diversify as a result of the cellulosic biofuel provision. As a result of the problems with the ethanol blend wall – vehicle and infrastructure compatibility – many companies are focusing on drop-in biofuels. These drop-in biofuels, like gasoline and diesel fuel made from biomass, do not face the same blend wall constraints as ethanol.

At Shell, we continue to invest in cellulosic biofuels and are working toward their commercialization. We believe it is essential that problems with the RFS be addressed to avoid the blend wall problem and provide appropriate incentives for cellulosic biofuels. This is needed to provide the regulatory certainty that is critical to underpin the substantial investments that are needed to commercialize cellulosic biofuels.

* * *

In closing, we continue to strongly advocate for revising the current RFS and lowering the renewable fuels mandates to levels that are consumable by vehicles on the road today and existing infrastructure. If EPA does not act to waive down the current renewable fuels volumes for 2013 and 2014, the RFS will continue to limit the supply of gasoline and diesel in the U.S. and have adverse impacts on consumers and the economy.

Sincerely,



John Reese
Downstream Policy and Advocacy Manager for North America

Attachment

Smithfield

Smithfield Foods, Inc.
200 Commerce Street
Smithfield, VA 23430

April 29, 2013

The Honorable Fred Upton
Chairman
House Committee on Energy & Commerce
2125 Rayburn House Office Building
Washington, DC 20515

The Honorable Henry Waxman
Ranking Member
House Committee on Energy & Commerce
2322A Rayburn House Office Building
Washington, DC 20515

RE: RENEWABLE FUEL STANDARD ASSESSMENT WHITE PAPER: Agricultural Sector Impacts

Dear Chairman Upton and Ranking Member Waxman:

I write to thank you for the thoughtful, evidence-based approach you are taking to reform the Renewable Fuel Standard (RFS). The series of bipartisan white papers you have initiated is an excellent first step to reform, and on behalf of Smithfield Foods, I appreciate the opportunity to offer comments. I hope this process will lead to the consideration and passage of reform legislation that provides relief for American farmers and the American consumer.

Smithfield Foods, Inc. is the world's largest pork producer. We are a vertically-integrated *Fortune* 500 food company, with annual sales of $13 billion and 46,000 employees worldwide. We are committed to producing good food responsibly, with an emphasis on creating shareholder value while simultaneously pursuing a broad, goals-defined sustainability program. We have been recognized by *Fortune* Magazine as the second-most admired food company in the world.[1] Recently the London FTSE Group named us to their prestigious "FTSE4Good" index for companies demonstrating globally-recognized corporate sustainability.[2]

Our single greatest input cost for raising hogs is the cost of corn. Corn meal comprises the majority of our feed, and its costs comprise 60-70 percent of the total cost of bringing an animal

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[1] Fortune, *World's Most Admired Companies: 2013,* http://money.cnn.com/magazines/fortune/most-admired/2013/list/.

[2] Global Newswire, *Smithfield Foods Again Named to FTSE4Good's Ranking of Worldwide Socially Responsible Companies,* http://globenewswire.com/news-release/2013/04/10/537407/10028087/en/Smithfield-Foods-Again-Named-to-FTSE4Good-s-Ranking-of-Worldwide-Socially-Responsible-Companies.html (April 10, 2013).

to market weight.[3] Smithfield and its family of companies are dependent upon our ability to manage input costs to be competitive in the world market. We are one of the largest corn buyers in the U.S., purchasing roughly 128 million bushels per year to feed our 16 million hogs.

The RFS requires 13.8 billion gallons of corn ethanol be blended into U.S. gasoline in 2013. Despite the fact that corn ethanol is a mature industry, and that actual volume of gasoline bought this year will be short of projections, and ethanol has one-third the energy content of gasoline, and ethanol's environmental benefit is dubious, the mandate for corn ethanol will increase over the next two years to 15 billion gallons, where it is set to remain through 2022.[4]

The result of this mandate is that 40 percent of the domestic corn crop is automatically diverted to ethanol production, which causes corn price volatility and hurts our business. Between 2005, when the RFS began, and 2012, the price of corn increased 300 percent.[5] While it is likely a variety of factors contributed to this price increase, studies such as "The RFS, Fuel and Food Prices, and the Need for Reform" by Dr. Thomas Elam (attached) clearly indicate that the driving force in this volatility is the relentless demand driven by the RFS. [6]

Absorbing this drastic price increase has been major challenge for our company. The cost of corn directly impacts the value of our hog farming segment and depressed value for our shareholders. Last year was especially difficult as corn prices shot to as high as $8.24 per bushel. Our farms were forced to take drastic measures to feed our hogs, including purchasing Brazilian corn for the first time in our history. These substantial cost increases are especially challenging for the 2,135 contract farmers we work with, who are less able to manage risk and absorb losses. The impact has been devastating to the greater pork industry. Between 2007 and 2010, 6,300 U.S. hog operations went out of business despite high prices for hogs.[7] These losses were driven by excessive corn prices.

RFS supporters claim that the current regime has sufficient flexibility to alleviate the price volatility created by the program. They cite the RINs program and the opportunity for a waiver from the EPA as safety valves for the program. In practice however, neither of these tools have worked. The RINs program offers little flexibility for refiners, and as we rapidly approach the blend wall, has seen extreme volatility of its own, with RINs prices increasing nearly 1,000 percent since this time last year.[8] The waiver process was exercised for a second unsuccessful time last year, with seven governors petitioning the EPA for relief, citing the tremendous strain

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[3] U.S. Congress, House, Committee on Agriculture, Testimony of National Pork Producers Council *Hearing on Livestock, Dairy & Poultry Sectors Air Concerns About Tight Feed Grain Supplies* (Washington, D.C. Subcommittee on Livestock, Dairy and Poultry, September 14, 2011), 3.

[4] Clean Air Act Section 211(o)(2)(B)(i)

[5] *Agriculture Prices,* National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA), http://www.nass.usda.gov/Publications/Todays_Reports/reports/agpr1212.pdf (December 31, 2012).

[6] Dr. Thomas Elam, *The RFS, Fuel and Food Prices, and the Need for Reform,* (April 18, 2013), 2.

[7] *Hearing on Livestock, Dairy & Poultry Sectors,* 6.

[8] Gerard Wynn, *"Blend wall" Explains Rising Ethanol Costs*, CNBC, http://www.cnbc.com/id/100577596 (March 21, 2013).

corn prices were placing on their states. Despite record high corn, soybean, and wheat prices, no waiver was granted.

The lack of flexibility in the mandate, coupled with the volatility of corn, soy and wheat prices driven by the RFS necessitates that the Committee act to reform the program. Smithfield supports H.R. 1462, the RFS Reform Act, as a possible legislative proposal to address the major problems in the mandate. The bill would keep the advanced and cellulosic ethanol targets in place, while concurrently eliminating the conventional biofuels mandate which is more economically disruptive and environmentally unfriendly. For a company like Smithfield, who is committed to sustainable practices, we support the development and commercialization of advanced and cellulosic biofuels. However, we cannot support the continued mandating of a corn ethanol, which artificially increases the cost of feed for our animals, and food for Americans.

We appreciate your efforts to find a bipartisan solution to the RFS problem. If we can offer further information for you, please feel free to contact me.

Yours,

Dennis Treacy
Executive Vice President and Chief Sustainability Officer
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The RFS, Fuel and Food Prices, and the Need for Reform

April 18, 2013

Dr. Thomas E. Elam
President, FarmEcon LLC

The information contained herein has been taken in part from trade and statistical services and other sources believed to be reliable. FarmEcon LLC makes no warranty, express or implied, that this third party information is accurate or complete. Funding for this study was provided by a coalition of food producing interest groups.

Table of Contents

Executive Summary

Current U.S. biofuels policy contains escalating corn-based ethanol blending requirements (the Renewable Fuel Standard - or RFS) that do not automatically adjust to energy and corn market realities. That same policy contains cellulosic ethanol requirements that do not reflect the fact that the biofuels industry, despite decades of effort and large subsidies, has failed to develop a commercially viable process for converting cellulosic biomass to ethanol.

Corn-based ethanol blending requirements have pushed corn prices, and thus ethanol production costs, so high that the market for ethanol blends higher than 10 percent is essentially non-existent. That same policy has also destabilized corn and ethanol prices by offering an almost risk-free demand volume guarantee to the corn-based ethanol industry. Domestic and export corn users other than ethanol producers have been forced to bear a disproportionate share of market and price risk.

Consumers have seen food prices increase faster than general inflation since the current RFS was enacted in 2007. Food affordability has stopped the long term trend of improving, and is deteriorating.

Job creation in the food sector has been substantially reduced by the diversion of corn to ethanol production. Almost 1 million potential food sector jobs that could have been created from 2007 to 2011 were not. Diversion of corn to ethanol production is one contributing factor to the prolonged recession in the U.S. labor market.

Increases in ethanol production since 2007 have made little, or no, contribution to U.S. energy supplies, or dependence on foreign crude oil. Rather, those increases have pushed gasoline supplies into the export market. Domestic gasoline production and crude oil use have not been reduced. If the RFS is made more flexible, and ethanol production shrinks due to market forces, we can easily replace ethanol with gasoline currently being exported.

This paper will argue that it is time to reform the current RFS. Corn users other than the ethanol industry need assurance of market access in the event of a natural disaster, and a sharp reduction in corn production. Ethanol producers should fully share the burden of market adjustments, along with domestic food producers and corn export customers. Ethanol prices should reflect the fuel's energy value relative to gasoline, not a corn price that is both inflated and destabilized by the inflexible RFS.

Finally, the RFS schedule should be revised to reflect the ethanol industry's inability to produce commercially viable cellulosic fuels. Policy should reflect reality when that reality does not reflect substantial and undeniable barriers to achieving policy goals.

Key Points

- Current ethanol policy has increased and destabilized corn and related commodity prices to the detriment of both food and fuel producers. Corn price volatility has more than doubled since 2007.
- Following the late 2007 increase in the RFS, food price inflation relative to all other goods and services accelerated sharply to twice its 2005-2007 rate.
- Post-2007 higher rates of food price inflation and declines in food affordability are associated with sharp increases in corn, soybean and wheat prices.
- On an energy basis, ethanol has never been priced competitively with gasoline.
- Ethanol production costs and prices have ruled out U.S. ethanol use at levels higher than E10. As a result, we exported 1.2 billion gallons of ethanol in 2011 and 740 million in 2012.

- Due to its higher energy cost and negative effect on fuel mileage, ethanol adds to the overall cost of motor fuels. In 2011 the higher cost of ethanol energy compared to gasoline added approximately $14.5 billion, or about 10 cents per gallon, to the cost of U.S. gasoline consumption. Ethanol tax credits (since discontinued) added another 4 cents per gallon. The 2012 cost was reduced to $7.6 billion by the expiration of the conventional biofuel tax credit (VEETEC).
- Using measures of gasoline prices and oil refiner margins, from 2000 through 2012 there was no statistically significant effect of increased ethanol production on gasoline prices or oil refiner margins.
  - Both statistical models showed very weak, statistically insignificant, associations between increased ethanol production and gasoline prices and oil refiner margins.
  - Factors that do account for gasoline prices and refining margins include: crude oil prices, crude oil inventories, gasoline inventories, net gasoline exports (exports minus imports), seasonality, and supply disruptions caused by hurricane Katrina, refinery outages, and methyl tertiary butyl ether (MTBE) gasoline additive withdrawal.
  - A similar model from Iowa State University found a negative effect of increased ethanol production on refiner margins and gasoline prices. That model used flawed methodology. Projected 2011 effects are unrealistic.
- In the U.S., the January 2007, through December 2012, increase in ethanol production had no effect on: 1) gasoline production; 2) crude oil imports; 3) crude oil consumption; or 3) refinery utilization.
- From January 2007, through December 2012, increased ethanol production displaced gasoline in the U.S. fuel supply, but did not cause reduced gasoline production. The displaced gasoline was exported. Gasoline consumption declined by more than the ethanol displacement, further boosting gasoline exports. In effect, the 2007 to 2012 increase in ethanol production has been exported.
- Declining U.S. oil imports are being caused by increased U.S. crude oil production, and higher refinery yields, not increased ethanol production.
- Abandonment of the conventional biofuel RFS would not affect overall U.S. fuel supplies, but would tend to reduce the volatility and level of corn and other important agricultural commodity prices to the benefit of both food and fuel producers.
- Given the realities of cellulosic biofuels, the RFS program should be amended to reflect the lack of technological progress in this area, and potential risks to the environment.

Ethanol Prices and Production Costs

Supporters of current ethanol policy have claimed that ethanol is saving American motorists money. That claim is partially based on the fact that ethanol typically sells for less per gallon than gasoline. The problem with that claim is that engines do not run on gallons, they run on energy. On an energy basis gasoline and ethanol are very different fuels.

Earlier in the modern history of ethanol use in motor fuels its main purpose was for a combination of octane enhancement and as a fuel oxygenator. In more recent times, with the dramatic increase in ethanol production, those limited markets have become saturated. To go beyond use as a fuel additive, and compete with gasoline as a fuel, ethanol must be priced competitively based on its energy content. This section will show that ethanol continues to be priced at a premium that prevents its widespread use beyond the universally authorized E10 (90% gasoline, 10% ethanol) blend level. The fact that substantial amounts of ethanol were exported in 2011 when the E10 market became saturated supports that fact.

Ethanol's value as a fuel is established by its energy content relative to competing fuels. Despite its higher octane rating, gallon of ethanol has only 67 percent of the net energy of a gallon of gasoline. As a result, in current gasoline engine technology, fuel mileage per gallon declines as ethanol content increases. Fuel mileage per BTU is approximately equal between gasoline and ethanol. This fact was born out in a tightly controlled test performed by Oak Ridge National Laboratory and the National Renewable Energy Laboratory. To quote from that study (page 3-1):

"The following trends from E0 to E20 were found to be statistically significant. Fuel economy decreased (7.7% on average), consistent with the energy density reduction associated with ethanol blending (in limited tests, this trend was observed to continue to E30)."

Ethanol must sell at a significant discount to gasoline to achieve equal fuel cost per mile. If ethanol blends higher than 10 percent are not competitively priced, the result will be failure of those fuels to achieve significant sales. That has been the fate of E85. According to recent Department of Energy statistics, ethanol blends of more than 55 percent account for only 1,000 barrels per week out of total gasoline production of about 8.8 million barrels per week. Ethanol blends under 55 percent, almost entirely E10, account for about 94 percent of U.S. gasoline production. There is little, or no, room for E10 to grow further, and E85 cannot grow due to its high cost. E15 will likely suffer a similar fate.

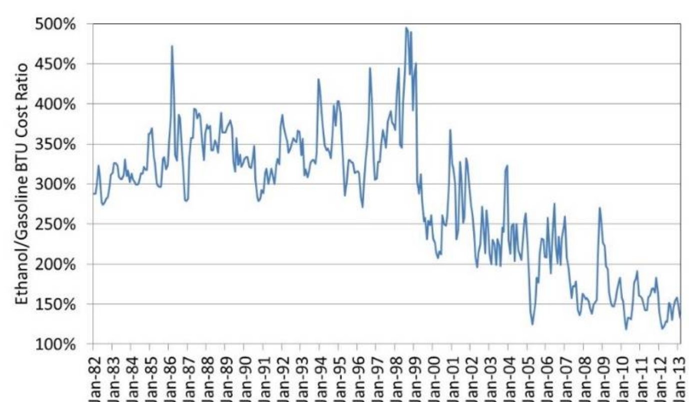
The Nebraska Energy Office publishes monthly averages of 87 octane unleaded gasoline and ethanol prices at Omaha fuel terminal rack locations. These averages represent ethanol prices near the center of U.S. ethanol production. They are among the lowest ethanol and gasoline prices in the country. This comparison is thought to be representative of relative prices across much of the United States. From January 1982, until February 2013, ethanol has never been priced at energy parity with 87 octane unleaded gasoline. The relative ethanol price has declined since 2000 as the octane and oxygenator markets have become saturated. However, since the current RFS was adopted in late 2007, ethanol energy has averaged a 60 percent average premium to gasoline at Omaha blending locations.

Key Point:

Ethanol is an expensive fuel. Compared to 87 octane unleaded gasoline at Omaha, Nebraska fuel terminals the cost of ethanol per gallon of gasoline energy has been higher than gasoline every month since 1982. Higher relative values prior to 2007 reflect an ethanol octane enhancement and oxygenator value premium. Recent declines in the ratio reflect a spike in wholesale gasoline prices.

Ethanol Price as Percent of 87 Octane Gasoline Energy

Omaha, Nebraska, January 1982 to February 2013



In 2011, the United States exported 1.2 billion gallons of ethanol, and 740 million gallons in 2012. A major reason was that ethanol's energy is more expensive than gasoline, and thus E85 cannot be priced competitively in the U.S. market.

Another way to look at the ethanol price premium compared to gasoline is ethanol's price difference per gallon of gasoline energy. As the next chart shows, the energy-equivalent per gallon price difference has declined only slightly since the 1980s. Since the current RFS was enacted in late 2007, the average price difference was $1.20 per gallon premium for ethanol energy versus gasoline energy. From January, 1982 until December 2007, the average was a $1.36 per gallon premium for ethanol energy. Again, ethanol energy has not been priced competitively with gasoline since 1982.

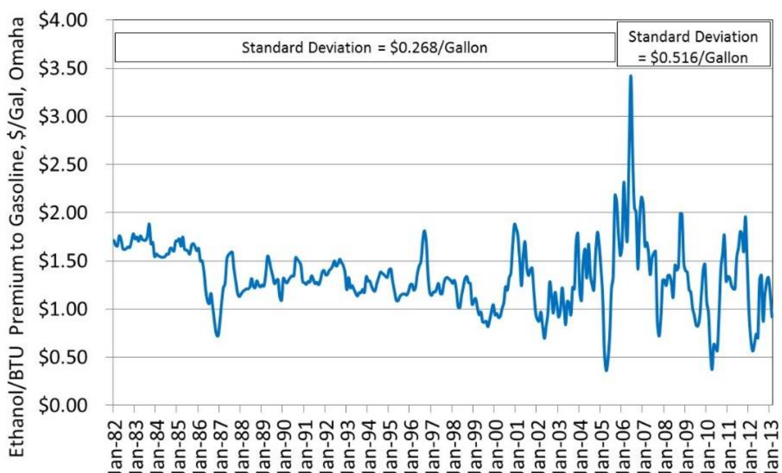
Not only has the ethanol energy price premium remained at high levels, the volatility of the premium has doubled. The standard deviation of the ethanol energy premium was $0.268 per gallon from 1982 to mid-2005, when the first RFS was enacted. Since then the standard deviation was $0.516 per gallon. A recent journal article by Bruce A. Babcock and Lihong Lu McPhaila shows that the RFS is a major cause of this increased volatility for both ethanol and corn prices.

Ethanol Price Premium/Gallon Gasoline Energy Equivalent

Omaha, Nebraska, January, 1982 to February, 2013

Key Point:

Ethanol is an expensive fuel. Since 1982, relative to 87 octane gasoline, ethanol energy has been priced at about a $1.30 higher per gallon of gasoline energy. That premium has declined slightly since 2007, but remains nearly as high on average as it was prior to the current RFS. Since the original 2005 RFS, the volatility of the price premium has doubled.



The impact of this increased volatility on fuel markets is difficult to understate. Gasoline blenders and their retail customers who might want to sell E85 have been discouraged by the state of flux in gasoline versus ethanol pricing. This pricing instability has likely been a detriment to installation of E85 fueling stations and flex-fuel auto purchases. As will be shown later, much of this increased volatility can be traced back to the impact of the inflexible RFS on corn use, corn inventories, and corn prices.

The most significant ethanol production cost is corn. Since the first RFS schedule in 2005, the corn cost in a gallon of ethanol has increased from about 50 percent to more than 80 percent of total ethanol production costs. Corn costs for ethanol producers have also been much more volatile. The increased volatility of corn costs is directly attributable to large increases in mandated corn use for ethanol production, resulting lower corn stocks, and increased corn price volatility.

Increases in corn prices since 2005 are primarily the result of both higher mandates for corn-based ethanol production and higher energy prices. Each played a significant role, and they reinforced each other in their corn price effects. Absent the RFS mandates and higher oil prices, corn prices would be much lower today. How much each of the driving forces affected corn prices and ethanol production is debatable, but there is no doubt that both were important.

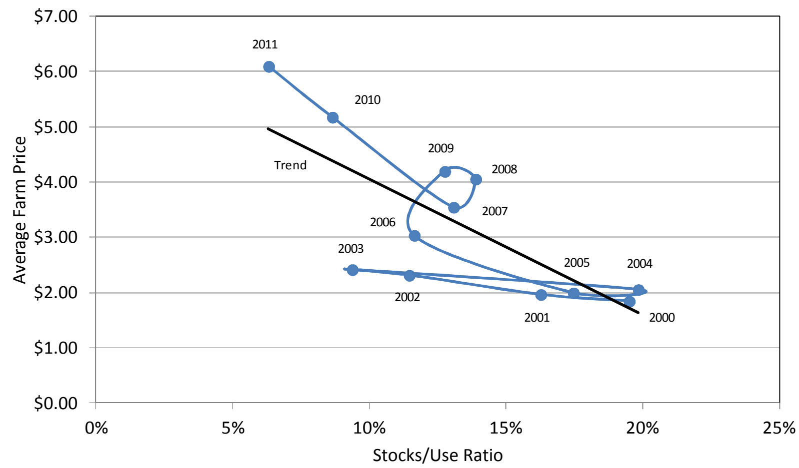
The next chart shows the 2000-2011 crop year average farm level corn prices versus the ratio of ending stocks-to-use. Clearly, as the stocks-to-use ratio declines there is a tendency for corn prices to rise.

Season-Average Corn Price vs. Stocks-to-Use Ratio

(Year is Year of Harvest, Black Line is Trend))

Key Point:

The increased demand for corn that has been partially the result of the inflexible RFS has caused corn stocks to decline to near-record low levels relative to total corn use. Tighter stocks have caused higher corn prices for all users, including ethanol producers.

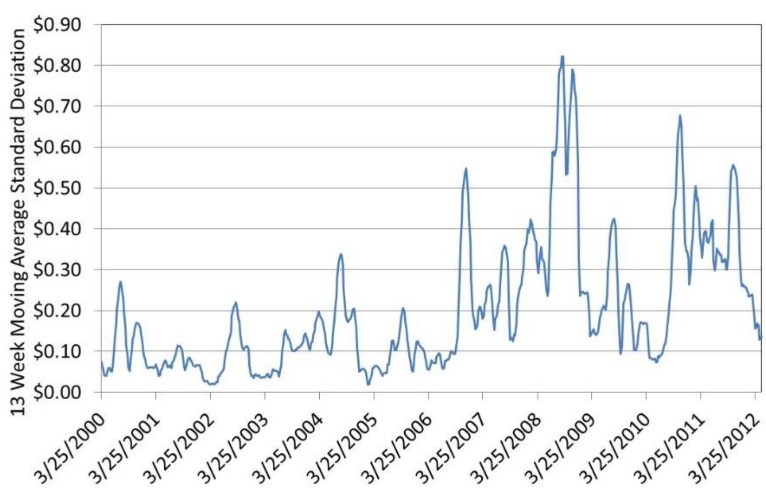


Less obvious than the increase in corn prices has been in the increase in their volatility. The next graph shows the 13 week standard deviation of weekly Central Illinois elevator corn bids. The volatility obviously increases markedly after the 2007 RFS. This higher volatility has increased business risks for all corn users. The result has been the bankruptcy of a number of ethanol companies and food producers.

13 Week Standard Deviation of Central IL Elevator Corn Bids

Key Point:

Tighter stocks shown in the chart above have also caused much higher corn price volatility for all users, including ethanol producers. This higher volatility has substantially increased business risks, resulting in a number of bankruptcies of ethanol and food producers.

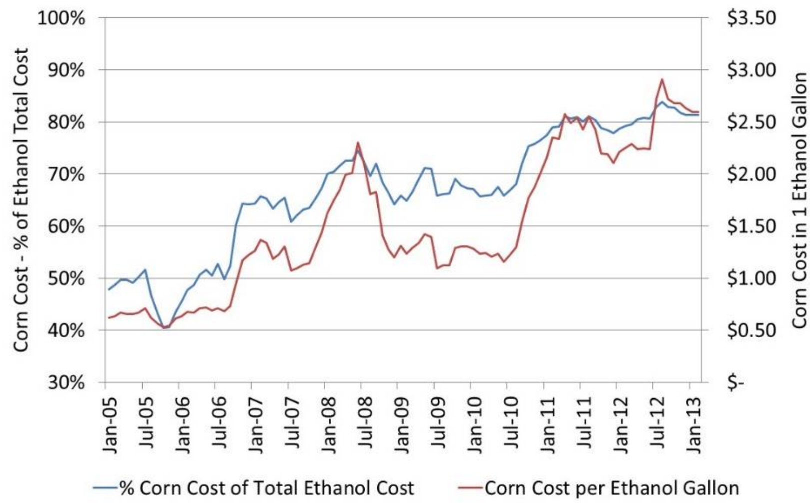


The impact of higher corn prices on ethanol production costs is shown in the following chart. Prior to the RFS, corn accounted for about a $0.60 cost per gallon of ethanol. The corn cost per gallon is now in the $2.50 to $2.75 range. Looking at the cost of just the corn used in ethanol for per gasoline-equivalent fuel energy produced, that cost is currently in the $3.75 to $4.10 range. This cost alone is well above recent wholesale prices for 87 octane unleaded gasoline.

Corn Cost Impact on Ethanol Production Cost

Key Point:

Higher corn prices have increased the cost of ethanol production. Corn now represents over 80 percent of the cost of ethanol versus 40-50 percent prior to the RFS. Higher ethanol prices are acting as a choke point on use of ethanol at blends higher than 10 percent.



Corn Prices and Food Production Costs

Corn is one of the key commodities used in U.S. food production. It enters the food chain via a wide range of products, but meat, poultry and dairy are the major users. Ranked by wholesale value of primary commodities, corn dwarfs the second and third ranking commodities, soybean products and wheat. Distiller's Grains (DGs), an animal feed by-product of ethanol production, are included with corn to arrive at the total value of corn used for U.S. food production.

Top Three U.S. Food Production Commodities, by Value, 2012/2013 Crop Year

Commodity	Units	Domestic Food Production Use	Price	Value/Cost, $ Million
Corn				
Corn as Grain	Bushels	5,787	$6.90	$39,930
DGs from Corn	Tons	33.7	$270	$9,099
Total Corn				$49,029
Soybeans				
Soybean Meal	Tons	29,900	$425	$12,708
Soybean Oil	Million Pounds	13,200	$0.49	$6,468
Total Soybeans				$19,176
Wheat	Bushels	1,386	$7.80	$10,811

Not only is corn important on its own, corn prices also influence wheat, soybeans and other important commodities. As corn prices have risen, so have prices of the other two major commodities. Increases in prices of these three major food production items have driven costs of U.S. food production significantly higher since the first RFS was introduced in 2005.

Cost of Corn, Soybean Products and Wheat Used In U.S. Food Production
Crop Years 2005-2012

Commodity	2005	2006	2007	2008	2009	2010	2011	2012	% Increase 2005-2012
Corn									
Corn as Grain	$12,310	$21,177	$30,454	$26,382	$23,057	$32,126	$37,152	$39,930	224%
DDGS from Corn	$946	$1,782	$3,333	$3,118	$3,478	$6,884	$8,266	$9,099	861%
Total Corn	$13,256	$22,959	$33,787	$29,500	$26,536	$39,011	$45,418	$49,029	270%
Soybeans									
Soybean Meal	$5,782	$7,059	$11,138	$10,181	$9,537	$10,470	$12,708	$12,708	120%
Soybean Oil	$3,845	$4,947	$7,985	$4,656	$5,081	$7,479	$6,468	$6,468	68%
Total Soybeans	$9,626	$12,006	$19,123	$14,837	$14,618	$17,948	$19,176	$19,176	99%
Wheat	$3,677	$4,507	$6,234	$8,034	$5,206	$6,430	$10,811	$10,811	194%
Total Cost	**$26,559**	**$39,472**	**$59,143**	**$52,371**	**$46,360**	**$63,389**	**$75,404**	**$79,016**	**198%**
Cumulative Increase		**$12,912**	**$45,496**	**$71,308**	**$91,109**	**$127,939**	**$176,783**	**$229,240**	

By 2012, the annual farm level cost of the three commodities had risen from $26.6 billion in 2005 to $79.0 billion, more than tripled. The cumulative cost increase over the 2005-2012 was $229.2 billion.

It should come as no surprise that the cost of food has increased much faster than overall inflation since 2005. The following table shows consumer level price inflation for selected food categories, and all items other than food, between calendar years 2005 and 2012. The time periods are before and after the 2007 RFS came into force. Overall price inflation of items other than food, even including energy, declined dramatically after December, 2007. The decrease was largely due to the 2008-2009 recession. In 2005 to 2007, food prices increased 9.6 percent, slower than the all items other than food increase of 10.5 percent. From 2008 to 2012 food prices increased 13.3 percent, all other items increased only 8.3 percent. Total inflation for all items other than food slowed by 21.2 percent from the period before the RFS compared to the period after. Food inflation increased 37.8 percent faster. Food categories that depend heavily on grains any edible oils saw even more rapid inflation increases after the RFS.

U.S. Price Inflation, Food, All Items Other than Food and Selected Food Categories

Before and After the 2007 RFS

CPI Category and Ratio From: To:	January-2005 December-2007	January-2008 December-2012	Change in Inflation
All CPI Items Other Than Food (Includes Energy)	10.5%	8.3%	-21.2%
All Food	9.6%	13.3%	37.8%
Cereals and Bakery Products	9.4%	16.6%	76.6%
Meats, Poultry, Fish, and Eggs	8.3%	16.3%	96.7%
Fats and Oils	5.0%	29.6%	493.1%

The rapid increase in the last three categories should come as no surprise. They all make heavy use of the three basic commodities shown in a table above. Ethanol from corn and biodiesel from soybean oil are both targeted by the 2007 RFS fuel blending mandates. Wheat and soybean prices have risen with corn due to the potential for corn to take wheat and soybean acreage, and the potential for wheat to substitute for corn in animal feeding.

Some studies have shown little or no contemporaneous, month-to-month, relationship between corn prices and consumer food prices. However, the effects are not month-to-month or limited to corn, but cumulative and spread across other basic commodities. Post-2007 food prices, especially categories that make heavy use of corn, wheat and soybean products, accelerated much rates much faster than overall inflation. The 2008-2009 recession had little negative effect on longer term food prices because those were being pushed up by the artificial demand of RFS mandates that increased faster than the ability to produce corn, wheat and soybeans.

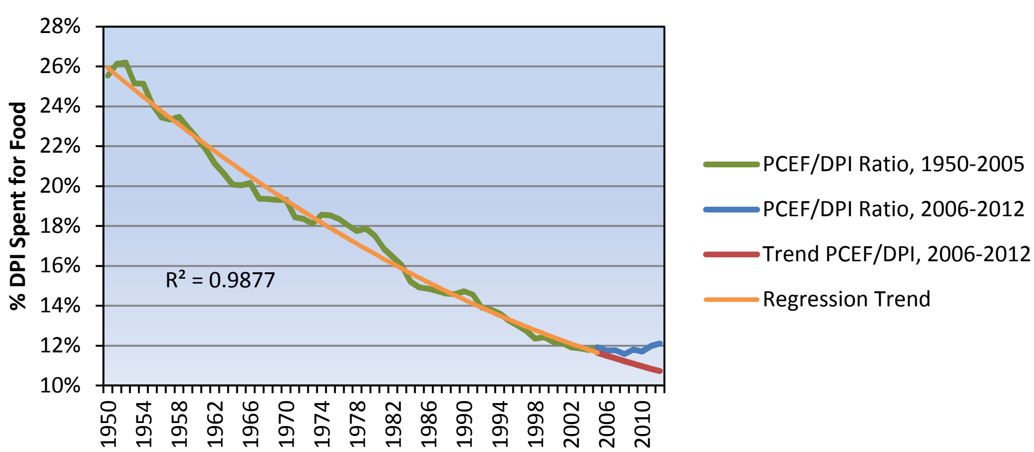
In addition, ethanol production costs and ethanol prices were also increased by the 2007 RFS. The result was that ethanol has been priced out of all blends except E10. Thus, the United Sates is producing surplus ethanol that cannot be sold here, and was having to export significant surplus ethanol until the 2012 crop disaster forced reductions in ethanol production!

Food Affordability Has Been Profoundly Affected

A major U.S. long term economic trend has been increasingly affordable food. Affordability has been commonly measured as the percent of disposable income spend for food. The trend is not a straight line; affordability improvement has been slowing over time, but was still trending down until 2006. Since 2006 this trend has reversed, and that reversal is the largest since 1950. Increasing food affordability has freed up income for spending on all other consumer goods and services, helping the economy grow and add jobs.

Since 2007, food prices are increasing compared to all other prices, and consumers' food costs are now increasing relative to the long term trend. The last time the gap grew in a manner similar to the current experience was during the 1970s when farm commodity prices boomed as a result of growing grain and soybean exports. The current gap is much larger than that one.

Personal Consumption Expenditures for Food (PCEF): Percent of Disposable Personal Income (DPI)

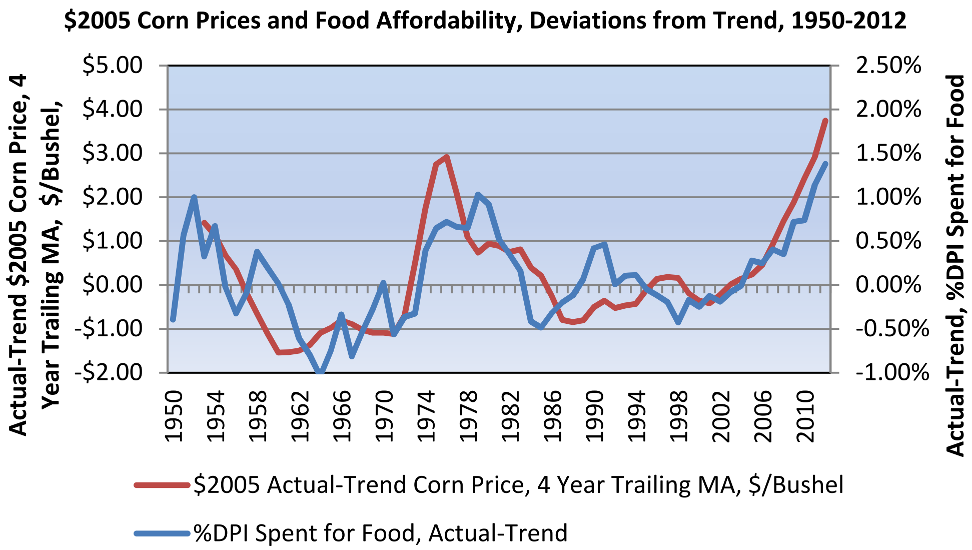


The graph above shows this departure from the long term affordability trend. Food spending is shown as a percent of disposable (after tax) personal income.

With a R^2 of 0.988, the 1950-2005 affordability trend line (orange) is a near perfect fit to the actual data (green). The blue line is 2006-2012 actual data, the red line is the 1950-2005 trend projected from 2006 to 2012. A declining trend shows improving food affordability. The blue line trends up, and indicates declining affordability. The gap between the 2012 actual and trend food affordability is about $160 billion in food spending.

The increasing food affordability gap is related to the sharp increase in post-2007 commodity prices. With a very long and involved chain of production and supply of all the items that use major crops, increases in their prices do not immediately show up at the supermarket or restaurant. In fact, short term volatility in major crop prices rarely show up at the consumer level. But, with the sustained price increases since 2005, we are now seeing major impacts on food production costs, retail food prices, and restaurant menu prices.

Looking at the record of corn prices and food affordability (measured as percent of disposable income spent for food, see next chart) there is a clear relationship between changes in corn prices and food affordability. As already mentioned, corn prices affect markets and prices for other farm products, so when corn prices rise as they have since 2005, other farm product prices will go up too, adding pressure to increase retail prices of a broad range of food prices.



The graph above shows the relationship between constant dollar (using the 2005 base year Personal Consumption Expenditures (PCE) price deflator) corn price deviations from trend versus food affordability deviation from trend. Due to the high year-to-year volatility of corn prices, a 4 year moving average of the corn price trend deviations is used. The data are, again, 1950 to 2012. An increase in food spending as a percent of DPI is a reduction in food affordability.

Costs to the Average Food Consumer, Family of Four and the U.S. Economy: The post-2005 increase in food costs relative to trend has had added significant expense to family food bills and the nation's food expense. The table below details these food cost increases versus the long term affordability trend.

In current 2012 dollars, the average person saw a 2012 food bill that was $514 higher than trend. For a family of four, the increased cost above the trend was $2,055.

For the country's food spending, the actual above-trend 2012 food bill was $162 billion. In perspective, the increase in food spending is about the same as annual consumer spending on either vehicle repairs, college education, or telecommunications. Given the outlook for sustained high major crop prices through mid-2013, we are likely to see another very large 2013 food bill increase.

Food Cost Increases Versus 1950-2005 Trend

Year	Per Capita Actual-Trend Cost, $2005	Per Capita Actual-Trend Cost, $Actual	Family of 4 Food Cost, $Actual	Family of 4 Actual-Trend Cost, $Actual	Total Economy Actual-Trend Cost, Billion $2005	Total Economy Actual-Trend Cost, Billion $Actual
2006	$79	$82	$15,589	$326	$24	$24
2007	$132	$139	$16,255	$557	$40	$42
2008	$116	$126	$16,754	$504	$35	$38
2009	$230	$250	$16,484	$1,002	$71	$77
2010	$238	$264	$16,807	$1,057	$74	$82
2011	$371	$423	$17,736	$1,690	$116	$132
2012	$440	$514	$18,017	$2,055	$139	$162

Of the $162 billion above-trend total food cost increase for the 2012 U.S. food bill, about $70 billion, or 44%, is due to 2005-2012 price increases for grains, soybean products, DDGS and hay. These are the major commodities used to produce our meats, eggs, dairy products, bread, bakery products, cereal, and are also included in a wide range of other supermarket and restaurant food items. In addition, costs for a wide variety of other related minor agricultural commodities have also increased.

The RFS was a major factor behind the increased corn demand that led to higher food prices and increased family spending. Nowhere in the world has there been any major biofuel production sector created without similar mandates or heavy subsidies. Absent the RFS and its blending mandates, the industry would not have the market power to create these disruptions to the nation's economic fabric and food production sector.

Has Increased Ethanol Production Created or Destroyed Jobs?

Direct versus Indirect and Induced Jobs: Economic activity in any sector will create activity in other sectors. Indirect jobs are created when, for example, a construction project in the meat processing sector creates jobs for the construction sector. For meat and poultry, indirect jobs are also created in the very large food wholesaling, retailing and foodservice sectors. Induced jobs are created when direct employees in a sector spend their income for goods and services in other sectors. For example, when an ethanol plant employee visits a doctor, jobs are supported in the medical care sector.

Drawing the line on what to count and not to count in indirect and induced jobs is always arbitrary. Direct jobs are the only ones we can count with a high degree of precision.

Impact on Direct Post-Farm Processing Jobs: If we examine corn use numbers in the context of post-farm processing sector direct jobs that are part of food versus fuel value-added chains, there is a dramatic difference. Each million tons of corn plus DDG used to produce meat and poultry supports 3,602.3 direct jobs in processing alone (524,500 ÷ 145.6). The same number for ethanol processing is 159.8 direct jobs (11,971 ÷ 74.9), only 4.4% as many per ton of corn used as meat and poultry processing. Clearly, diverting corn from meat and poultry production to ethanol reduces the net employment opportunities.

Direct Jobs per Million Tons of Corn/DDG Use and Indirect/Induced Jobs Multipliers
Ethanol versus Meat and Poultry Processing

Item	Value
Direct Jobs in Ethanol Processing Sector	11,971
Direct Jobs in Meat and Poultry Processing Sector	524,500
Million Tons of Corn Used in Ethanol Production Net of DDG Production	74.9
Million Tons of Corn and DDG Used in Meat and Poultry Production	145.6
Direct Jobs per Million Tons of Corn and DDG Used in Ethanol Processing Sector	159.8
Direct Jobs per Million Tons of Corn and DDG Used in Meat and Poultry Processing Sector	3,602.3
Claimed Indirect and Induced Jobs in Ethanol Processing	383,260
Assumed Ethanol Processing Jobs Multiplier	**32.5**
Claimed Indirect and Induced Jobs in Meat and Poultry Processing	1,269,500
Assumed Meat and Poultry Processing Jobs Multiplier	**2.4**

Direct employment in meat and poultry processing is over 32 times the number directly employed by ethanol processors. Put another way, for every direct job at risk in the ethanol industry, there are more than 32 direct jobs at risk in meat and poultry value-added sectors. Or, put another way, corn used in meat and poultry production creates more than 32 times the number of direct jobs than the same amount of corn used in ethanol production. Unintended consequences of the RFS are putting large numbers of current and potential food sector jobs at risk in exchange for minimal job gains in ethanol production and value.

A recent Renewable Fuels Association employment study claimed an added 32.5 indirect and induced jobs per direct employment job in the ethanol industry. The meat and poultry study claimed a more modest 2.4 jobs. Given the vastly lower post-processing value added to ethanol versus meat and poultry, the higher jobs impact multiplier for ethanol is extremely dubious.

Impact on Indirect and Induced Post-Farm Jobs: As shown in the table above, both meat and poultry and ethanol production affect many jobs outside their direct value chains. Indirect jobs are those that support the activities of the value adding process, but are defined as belonging to other economic sectors. These jobs include equipment and services suppliers, construction, hired transportation, travel, government employees, and a myriad of other occupations that support the direct employment sector. Induced jobs are those supported by the income earned by direct and indirect jobs holders. Induced jobs span the entire economy.

The methodology used to estimate the number of indirect and induced jobs is, by its nature, somewhat arbitrary. In theory, all economic activity has some degree of impact on all other economic activity. Some of those impacts are major, and easily observable. Construction work on a meat processing or ethanol plant obviously causes meaningful impact on the local construction sector, and its suppliers. A million gallons of ethanol produced in the U.S. has a theoretical, but not meaningful or measurable, impact on European grain production and associated jobs. Drawing the line between meaningful and negligible impacts will always involve judgment on where to stop counting. However, these impacts are very real.

Both meat and poultry groups and the ethanol industry have published recent indirect and induced job impact estimates. A 2011 study sponsored by the Renewable Fuels Association claimed 401,600 direct, indirect and induced jobs are associated with ethanol production. The Renewable Fuels Association estimate implies that a million tons of corn used in ethanol production affects 5,359 jobs (401,400 ÷ 74.9).

According the 2009 American Meat Institute (AMI) study, 1,794,000 direct, indirect and induced jobs are involved in meat and poultry production and processing. Meat and poultry production and processing system touches 10,749 jobs per million tons (1,794,000 ÷ 166.9), or 2.0 times the number of ethanol jobs. Even accepting very dubious ethanol industry indirect and induced jobs claims, corn used to produce meat and poultry creates significantly more employment.

A 2012 study for the U.S. poultry (broilers, turkeys and eggs) industry, using the same model employed by Renewable Fuels, estimated 327,400 direct jobs and a total of 1,337,030 direct and indirect jobs. The total number of jobs affected is similar to the AMI study. Many of those jobs are in the processing, retailing and foodservice sectors that overlap both poultry and other meats.

Evidence of Economic Damage and job Losses from Employment Statistics: One symptom of reduced meat and poultry consumption shows up in recent declines in indirect food sector jobs. From 2002 to 2007 direct employment, on a full time equivalent (FTE) basis, in food production, processing, retailing and foodservice increased by 751,000. From 2007 to 2011 (2012 data are not available as of this time), employment in the same area declined by 195,000 FTE jobs. The net swing in job creation was 941,000 jobs. This change in job creation is partially attributable to the declines in meat and poultry consumption in 2007-2011 versus 2002-2007.

Full Time Equivalent Direct Employment in Food-Related Sectors (000s)

Industry	2002	2007	2011
Agriculture, Farming	747	643	643
Food processing	1,689	1,622	1,575
Food stores	2,558	2,527	2,454
Food Service	6,718	7,671	7,596
Total Food Related FTE Employees	11,712	12,463	12,268
Net Change		**751**	**(195)**

Has Increased Ethanol Production Reduced Gasoline Prices?

A recent Iowa State working paper claimed to show that increased ethanol production lowered the average 2011 gasoline price by $1.09 per gallon. To get that result the authors used an indirect, convoluted, calculation based on a highly dubious statistical model, since refuted by both this study and a more complete analysis from MIT and UC Davis.

With a more direct approach using actual (not the arbitrarily deflated data used in the Iowa State study) energy prices, several statistical models were estimated. All show that increased ethanol production from January 2000 through February 2012 had no statistically significant effect on gasoline prices or oil refiner margins. Furthermore, simple trends of gasoline energy equivalent ethanol production and U.S. gasoline exports show that increased ethanol production since 2007 has added nothing to the U.S. fuel supply. Rather, the increase in ethanol production has shifted U.S. gasoline from domestic use to exports.

Statistical Models

To estimate an impact of ethanol production on gasoline prices or oil refiner margins, an approach similar to the Iowa State paper was taken. Two models were used. Both of the models are based on monthly data for January 2000 through December 2012. All energy data are from the U.S. Department of Energy, Energy Information Administration.

Model 1: Gasoline Prices, Crude Oil Prices, Ethanol Production and Other Related Factors:

The New York harbor conventional gasoline, regular grade, monthly average price (cents per gallon) was explained using the following factors:

1. U.S. Crude Oil Composite Acquisition Cost by Refiners (Dollars per Barrel)
2. U.S. Fuel Ethanol Production (Thousand Barrels)
3. U.S. Percent Utilization of Refinery Operable Capacity (Percent)
4. U.S. Ending Stocks Excluding Strategic Reserves (Thousand Barrels)
5. U.S. Motor Gasoline Ending Stocks (Thousand Barrels)
6. Net Gasoline Exports (Exports-Imports, Thousand Barrels)
7. Monthly Seasonal Effects
8. Katrina Effect, September to October 2005
9. MTBE Effect, April to August 2006
10. 2007 Refinery Outages Effect, March to July 2007

Except for ethanol production and net gasoline exports, all of the factors were statistically significant. The model shows that ethanol production had a small positive, but statistically meaningless, effect on gasoline prices. The estimated equation explained 98.7 percent of the variation in gasoline prices. Crude oil prices were by far the leading driver of gasoline prices.

The model shows that increasing ethanol production was very weakly associated with higher, not lower, gasoline prices. While interesting, the model really shows that increasing ethanol production did not depress, or increase, gasoline prices. Crude oil prices are the major driver.

Detailed results for both models are in the appendix to this study.

Model 2: 3:2:1 Crack Spread, Crude Oil Prices, Ethanol Production and Other Related Factors:

This model closely resembles the Iowa State paper 3:2:1 crack spread model. There are two major differences. The Iowa State paper deflated the crack spread by the Producer Price Index (PPI) of crude energy material. This version uses the actual, non-deflated, crack spread. The Iowa State model also did not include crude oil prices as a driver of the margin, or the MTBE and refinery outage events.

The "Crack Spread" is a common measure of refiner margins above the cost of crude oil. It is the weighted value of two major refiner products, gasoline and distillate fuel oil, minus crude oil cost. It is the value of 2 barrels (84 gallons) of gasoline, 1 barrel (42 gallons) of distillate fuel oil, versus the total value of the price of three barrels of crude oil. For February 2012 the crack spread was:

Gasoline Value: $3.044/gallon x 42 gallons per barrel x 2 barrels = $255.70
+ Fuel Oil Value: $3.196/gallon x 42 gallons per barrel x 1 barrel = $134.23
<u>- Crude Oil Value: $107.19/barrel x 3 barrels = $321.57</u>
= $68.36 per 3 barrels of crude oil; or $22.79 per barrel of crude oil, the value used in the model.

The variables used to explain the crack spread are the same as used in Model 1. The results are also almost the same. Ethanol production had a small negative, but statistically meaningless, effect on the crack spread. Net gasoline exports were also statistically insignificant. All statistically significant variables had the expected direction of influence on the crack spread.

The model explained 73.6 percent of the variation in the crack spread.

Conclusions

Measures of gasoline prices and oil refiner margins were used to model the effect of increasing ethanol production on those prices and margins. The monthly data used spanned January 2000 through December 2012. In the models increasing ethanol production was statistically insignificant in explaining wholesale gasoline prices or refiner margins.

The overall conclusion is that increasing ethanol production over the 2000-2012 period had no significant effect on wholesale gasoline pricing or refiner margins.

In both models net gasoline exports were also statistically insignificant. Increased ethanol production has caused gasoline exports to increase, but those increased exports have not depressed gasoline prices or refining margins.

Why Do These Results Differ from Iowa State's Paper?

There are several items that contribute to the differences between the Iowa State results and these.

For the 3:2:1 Crack Spread version there are three major differences. The Iowa State version deflated the spread by a Producer Price Index (PPI) for crude energy materials. This study did not deflate the crack spread, but used actual data. This study also included crude oil price effects, an important variable.

The deflation of the crack spread may have produced a spurious result in the Iowa State version. Their model showed a statistically significant negative effect of increasing ethanol production on the spread. However, deflating that spread by the cost of energy materials causes it to not increase as fast as the actual raw data. Thus, with the crack spread increases held down in a time of increasing ethanol production and energy costs, there is a measured negative effect, even if one does not exist in the actual, non-deflated, data.

A second major difference is that both models in this paper included crude oil prices as a variable to explain the crack spread. The reason is that oil refineries use some oil in their processing. As crude oil prices increase, the crack margin should also increase to cover those higher costs. The model results confirm this effect. The effect of crude oil cost is positive, highly significant, and contributes to the different model results.

Finally, all of this paper's price and margin models include the effects of major March-July 2007 refinery outages that caused petroleum product prices and margins to increase over those months. The effect is statistically significant. Also included is an April-August 2006 gasoline price and margin increase associated with the withdrawal of the MTBE additive in several areas of the country. The effect is statistically significant. Neither of these market disruptions was considered in the Iowa State paper.

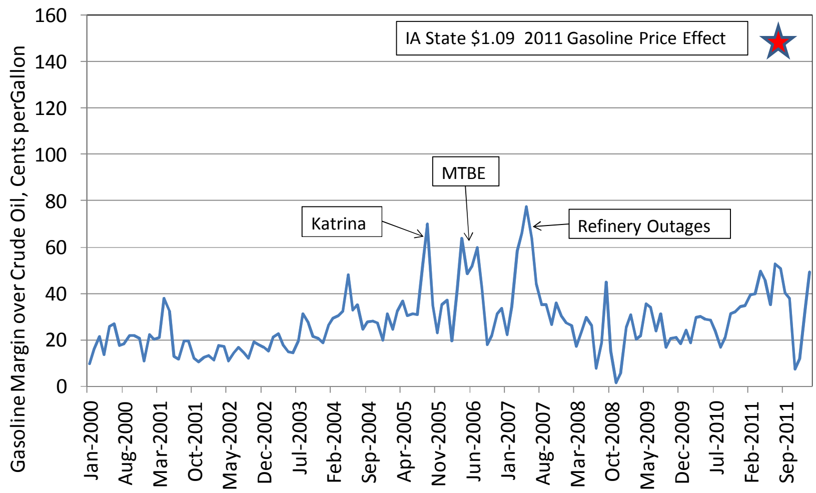
Using a more complete model, and actual prices and refiner margins, the effects of increased ethanol production on gasoline prices and oil refiner margins shown in the Iowa State model disappear.

Other Iowa State Paper Issues

There are several other issues with the Iowa State paper's results. The Iowa State 3:2:1 crack spread model uses a deflated spread to estimate the impact of increasing ethanol production. They then use that result to project an actual price difference for gasoline. Mixing deflated model results and actual non-deflated price data is statistically problematic.

Gasoline Price Margin over Crude Oil Price, 2000-February, 2011

> **Key Point:**
>
> The Iowa State finding that 2011 gasoline prices would have been $1.09 higher without ethanol production increases is out of line with historical prices and the fact that we are producing large gasoline exports. The actual 2011 gasoline premium to crude oil was 37.1 cents/gallon. An added $1.09 makes that margin $1.46.



More significantly, the Iowa State authors do not seem to realize that their extrapolated $1.09 per gallon increase in 2011 gasoline price relative to the crude oil price would cause major changes in supply-side market behavior (preceding graph). The 2000-2011 average gasoline crack price spread was 27.8 cents per gallon. The 2011 margin averaged 37.1 cents. A $1.09 increase in that margin would lead to refineries quickly increasing gasoline production and reducing gasoline exports. The increase in gasoline supply available to the U.S. market would largely, likely entirely, wipe out the higher gasoline price.

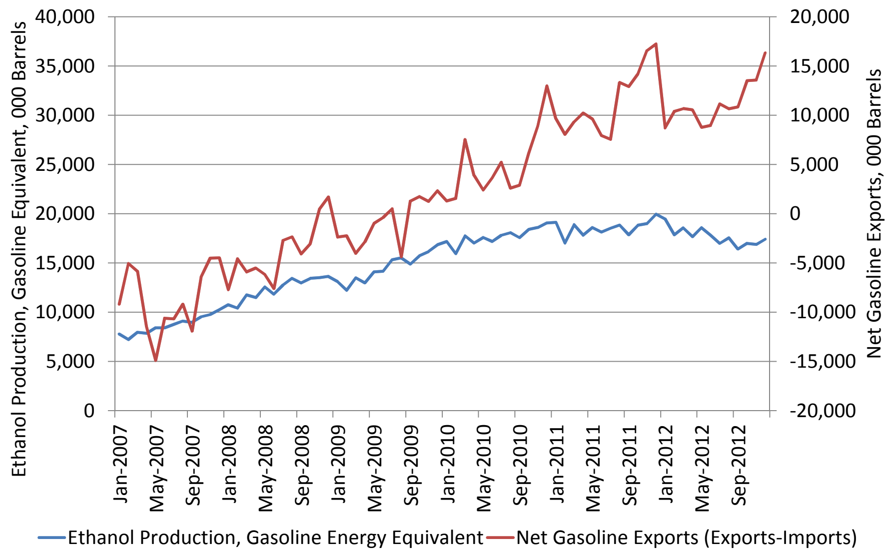
Put simply, a $1.09 gasoline price increase in 2011 would have never happened. There is enough U.S. and global spare capacity to produce more gasoline, or the United States could export less, and bring gasoline prices down relative to crude oil.

Has Increased Ethanol Production Increased U.S. Energy Supplies?

Another fact that supports the lack of impact of increased ethanol production on gasoline prices is that more ethanol production has not added to the U.S. energy supply. Rather, ethanol has displaced some U.S. gasoline consumption, but not production. The gasoline that was displaced from 2007 to 2012 was exported (next chart).

Monthly Ethanol Production (Gasoline Energy Equivalent) and Gasoline Exports

> **Key Point:**
>
> The increase in ethanol production since 2007 has displaced U.S. gasoline consumption, not added to the domestic energy supply. All of the energy produced by the added ethanol, and more,



In the chart above ethanol production was corrected for the fact that ethanol has only 67 percent of the energy in gasoline. Net gasoline exports are calculated as exports minus imports. Until about 2009 the U.S. was a net gasoline importer, thus the negative exports until then.

How can the ethanol industry claim that they are adding to the U.S. liquid fuel supply, or affecting prices, when ethanol production has had no significant effect on gasoline production?

The ethanol industry has also claimed that “Ethanol is now 10 percent of the U.S. motor fuel supply.” This is a very misleading statement.

In 2012, about 94 percent of U.S. gasoline was sold as E10, containing 10 percent ethanol by volume, but only 6.7 percent by energy content. Measured by volume, and for gasoline alone, the claim is very close to the fact. That is far from the whole story. A gallon of ethanol is not a gallon of gasoline, and gasoline is a far cry from the entire U.S. liquid fuels supply.

Gasoline is not the only liquid fuel used in the United States. According to the U.S. Department of Energy, 2012 U.S. total liquid fuel consumption was about 5.199 billion barrels. Gasoline-equivalent ethanol consumption was about 203 million barrels (table below). U.S. ethanol energy consumption was only 3.9 percent of U.S. liquid fuel consumption, not 10 percent. On a global scale, U.S. ethanol energy production contributed well under 1 percent of global liquid fuels consumption.

U.S. Ethanol Production Versus U.S. and Global Liquid Fuels Consumption

Item	2012, 000 Barrels
U.S. Ethanol Consumption, Gasoline Equivalent	202,549
Total U.S. Liquid Fuels Consumption	5,199,910
Ethanol Percent of U.S. Liquid Fuels	3.9%
U.S. Ethanol Production, Gasoline Equivalent	212,166
Global Liquid Fuels Consumption	32,499,600
U.S. Ethanol Percent of Global Liquid Fuels	0.65%

Does Ethanol Save Motorists Money?

The ethanol industry claims that increased use of ethanol fuel is saving motorists' money. We have already shown that higher ethanol production has had no effect on gasoline prices. That claim is also based in part on the fact that ethanol now typically sells for less per gallon than gasoline. Once again, a gallon of ethanol displaces only 0.67 gallons of gasoline. On an equal energy basis, a gallon of ethanol has never sold for less than a gallon of gasoline.

2011 Wholesale Level Cost of U.S. Ethanol Consumption

Item	2012
Gasoline Average Price per Gallon	$2.95
Ethanol Average Price per Gallon, Gasoline Equivalent	$3.54
Ethanol Price Premium per Gallon	$0.59
Billion Gallons of Ethanol Consumed	12.95
Ethanol Cost to Motorists, $Billion	$7.61
Actual Ethanol Average Price per Gallon	$2.37

The table above shows that the 2012 ethanol price premium added about $7.6 billion to motorists' fuel bills. That cost was about half of 2011. Elimination of the conventional ethanol tax credit on January 1, 2012 saved $5.7 billion in federal outlays, and reduced the wholesale ethanol price by about $0.40 cents per gallon. The lower ethanol price reduced the cost of ethanol in the E10 blend that was 94% of sales.

Has Increased Ethanol Production Reduced U.S. Crude Oil Imports?

One claim made by the ethanol Industry is that ethanol substantially reduces U.S. oil imports. On the surface, that may seem obvious. The logic is that ethanol replaces gasoline, and if less gasoline is consumed we need to import less oil. The real world is not that simple. Increased ethanol production since 2007 has not replaced U.S. crude oil imports. Rather, since 2007, increased ethanol production has increased gasoline exports.

The Renewable Fuels Association claims that 2011 ethanol production reduced U.S. oil imports by 485 million barrels. However, on an energy basis the U.S. consumed only 188 million barrels of ethanol in 2011. How can 188 million barrels replace 485 million barrels?

The claim is apparently based on the theory that for every barrel of ethanol production there is no need to import all of the crude oil used to produce that barrel of gasoline. Since a barrel of crude oil yields about half a barrel of gasoline, the theory is that a barrel of ethanol actually replaces more than one barrel of crude oil imports. The first problem with this theory is that if the U.S. did reduce crude oil imports, there would less production of all crude oil-based fuels, and other products other than gasoline. The U.S. would then need to import those other products. So, about half of the 485 million barrel claim makes no contribution to reducing dependency on imported petroleum. It does not matter if it is imported crude oil or refined products, both represent dependency on "foreign oil."

A second problem is that a barrel of ethanol actually replaces only 0.67 barrels of gasoline. U.S. fuel ethanol use in 2012 was about 281 million barrels. That is the energy of 188 million barrels of gasoline, and the most gasoline that fuel ethanol could have replaced.

If there is any replacement of crude oil and refined product imports, the actual maximum reduction in foreign dependency is about 40 percent of the claimed amount. Even that claim may not be true if U.S. gasoline production did not decline in line with the increase in gasoline energy equivalent ethanol production. Data from the Department of Energy will show if U.S. gasoline production declined, or not. If gasoline production declined, it is also expected that there would be declines in the other major refinery production stream, distillate fuel oil used to make diesel, heating oil and jet fuel.

The next table summarizes 2007 to 2012 U.S. production and use for gasoline, ethanol, distillate fuel oil and crude oil use. U.S. finished gasoline production, net of the ethanol it includes, has increased, not declined, since 2007. Since gasoline consumption declined, gasoline net exports have increased more than production. That means that the U.S. demand for the oil needed for gasoline production has not declined at all. Use of crude oil did decline slightly, but that was due to increased refinery fuel yields, not refined product supply reductions.

U.S. Gasoline and Ethanol, Production, Trade and Consumption, 2007-2012

Year	Finished Gasoline Production - Ethanol Used (Thousand Barrels)	Gasoline Net Exports (Thousand Barrels)	Gasoline Production - Net Exports (Thousand Barrels)	Ethanol Used for Blending (Thousand Barrels, Gasoline Equivalent)	Gasoline Production - Net Exports + Ethanol Used (Thousand Barrels, Gasoline Equivalent)	U.S. Refinery and Blender Net Production of Distillate Fuel Oil (Thousand Barrels)	U.S. Refinery and Blender Net Input of Crude Oil (Thousand Barrels)
2007 Actual	2,914,011	(104,248)	3,018,259	91,524	3,109,783	1,508,530	5,532,097
2008 Actual	2,938,589	(47,541)	2,986,130	127,356	3,113,486	1,571,539	5,361,287
2009 Actual	2,965,771	(10,210)	2,975,981	161,440	3,137,421	1,477,534	5,232,656
2010 Actual	3,020,517	58,954	2,961,563	191,542	3,153,105	1,541,503	5,374,094
2011 Actual	3,008,762	136,539	2,872,223	199,168	3,071,391	1,637,771	5,404,347
2012 Actual	2,947,293	134,069	2,813,224	202,549	3,015,773	1,639,606	5,492,025
2007-12 Change	**33,282**	**238,317**	**(205,035)**	**111,025**	**(94,010)**	**131,076**	**(40,072)**

From 2007 to 2012, actual U.S. gasoline production and gasoline net exports both increased. Gasoline supplied to the U.S. market declined, ethanol use increased, and on balance total gasoline and ethanol (on an energy basis) declined. On balance, all the gasoline displaced by ethanol, plus a significant amount of ethanol, was exported. Net gasoline exports increased by more than twice the increase in ethanol blending use. Net gasoline exports of 134,069,000 barrels in 2012 were more than the 2007-2012 111,025,000 barrel increase in ethanol blending (gasoline energy equivalent). Crude use declined, but not due to refined fuel product production reductions.

One way to look at what happened as a result of increased ethanol production is that the RFS has forced almost all of the 2007-2012 ethanol production increase to be used in the U.S. In a very real sense, all of the energy contained in the 2007-2012 ethanol production increase was actually exported in the form of gasoline because there was no market for it here! We could have exported all of that 111,025,000 barrels of 2007-2012 increased ethanol production (gasoline energy equivalent) and still been a net gasoline exporter in 2012!

In other words, the 2007-2012 increase in ethanol production increased the global energy supply, but that energy was exported from the U.S. in the form of gasoline. Increased ethanol production since 2007 has not increased U.S. motor fuel consumption, or reduced crude oil use, or crude oil imports. That fact helps make sense out of the statistical model results that show no impact of increasing ethanol production in gasoline prices.

A major factor in reduced crude oil imports and use was increased total refiner fuel yield. As shown in the next table, the total gasoline and fuel oil yield increased from 71.6 percent in 2007 to 74.3 percent in 2012. Refiners reduced gasoline yields slightly due to its declining consumption. Versus 2007 yields, the yield increase saved 149 million barrels of 2012 crude oil use.

But, why did oil refiners continue to produce more gasoline when ethanol production was increasing? Gasoline is not the only important fuel produced from crude oil. Diesel, aviation and heating fuels made from distillate fuel oil are also very important to refiners. Total demand for those products was increasing from 2007 to 2012. Ethanol cannot replace any of those other refinery products.

Refinery Yields, Two Major Products

Year	Gasoline Yield	Distillate Fuel Oil Yield	Total Gasoline and Distillate Fuel Oil Yield
2007	45.5%	26.1%	71.6%
2008	44.2%	27.8%	72.0%
2009	46.1%	26.9%	73.0%
2010	45.7%	27.5%	73.2%
2011	44.9%	28.9%	73.8%
2012	45.2%	29.1%	74.3%

To meet the demand for fuels other than gasoline, and keep refineries running at efficient rates, oil companies had to maintain crude oil use even as ethanol supplies grew and gasoline sales fell. With U.S. gasoline consumption on the decline, and ethanol adding to the gasoline supply, refiners simply started to produce slightly less per barrel of oil, and export more, gasoline to balance their total fuels supply and demand.

RFS Impact on Corn and Meat Market Conditions

In the post-RFS era grain and soybean prices have reached record-high prices, and volatility levels are the highest seen in modern history. Such an outcome is to be expected given the fixed nature and size of the RFS blending mandates versus forces of nature that largely determine biofuel feedstock production.

Consequences of high, volatile, grain and soybean prices have been detrimental to both the food and ethanol fuel sectors, and the overall economy. As was pointed out earlier, since 2007 food price inflation has accelerated to double the pre-2007 rate relative to non-food prices. Higher food prices, and their impact on food spending, have acted as a drag on post-2007 economic growth, and recovery from the 2008-2009 recession. Job creation has also been slowed.

The effects of the fixed RFS can be seen in the next table that details the 2005 to 2012 corn supply and use situation. The 2007 RFS promise of guaranteed ethanol use helped drive corn used for ethanol from 1.6 billion bushels in the 2005/2006 crop year to 5.0 in 2011/2012 before the 2012 crop disaster forced use down to 4.55 billion in 2012/2013. That increase in ethanol use forced higher prices and significant rationing of corn among feed users and export customers.

Feed use of corn declined from 6.2 billion bushels in 2005/2006, to only an estimated 4.4 billion in 2012/2013. Part, but not all, of the decline in corn feeding was offset by the increase in distillers' grains that are a by-product of ethanol production.

There are no official USDA estimates of distillers' grains production or stocks, but export data are available. To estimate distillers' grain feed use a standard yield of 18 pounds of 10 percent moisture distillers' dried grains with solubles (DDGS) per bushel of corn used for fuel ethanol production was assumed. That production volume was then factored up to from 10 percent to 14 percent moisture, the standard for corn. That supply was assumed to substitute for corn on a 1:1 basis. That is, 56 pounds of 14 percent moisture DDGS was assumed to replace one bushel of corn. Exports were subtracted from production to obtain domestic supply. DDGS has no use other than feeding, and inventory data are not available, so the entire domestic supply was assumed to be fed in the year of production.

Even with the add-back of DDGS, total feed use of corn plus DDGS declined from about 6.6 billion bushels in 2005/2006, to an estimated 5.7 billion bushels in 2012/2013.

Corn exports declined from about 2.1 billion bushels in 2005/2006 to an estimated 0.8 billion bushels in 2012/2013.

Both of these declines in use are the result of farm level corn prices increasing from $2.00 for the 2005/2006 crop year to almost $7.00 in 2012/2013. Higher corn prices (and associated increases in wheat and soybean product prices) have dramatically raised the costs of producing meat and poultry. Our former export customers have turn largely to South America for their corn needs.

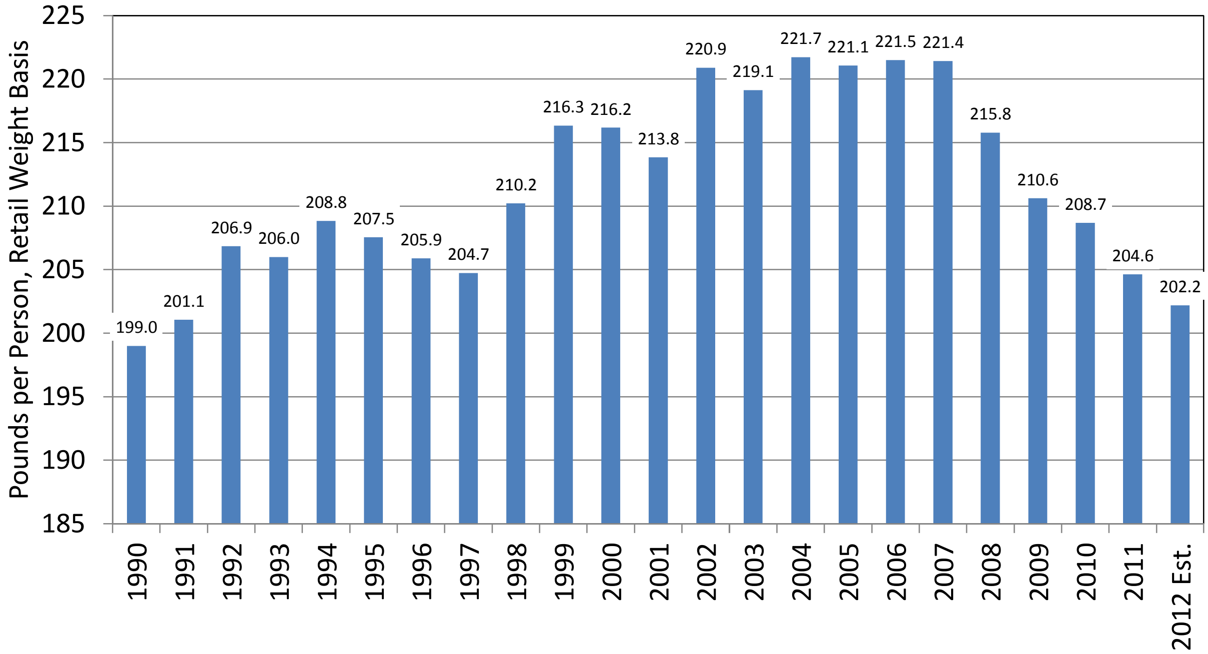
April 10, 2013 USDA Corn Production, Supply and Demand Estimates

Item	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	2011/ 2012	2012/2013 USDA Fcst.
Area Planted (Mill. Ac.)	81.8	78.3	93.5	86.0	86.4	88.2	91.9	97.2
Area Harvested (Mill. Ac.)	75.1	70.6	86.5	78.6	79.5	81.4	84.0	87.4
Yield (Bu/Ac.)	148.0	149.1	150.7	153.9	164.7	152.8	147.2	123.4
Beg. Corn Stocks (Mill. Bu.)	2,114	1,967	1,304	1,624	1,673	1,707	1,128	990
Corn Production (Mill. Bu.)	11,114	10,535	13,038	12,092	13,092	12,447	12,360	10,780
Corn Imports (Mill. Bu.)	9	12	20	14	8	28	29	125
Total Corn Supply (Mill. Bu.)	13,237	12,514	14,362	13,729	14,773	14,182	13,517	11,895
Corn Feed Use (Mill. Bu.)	6,155	5,598	5,938	5,182	5,125	4,793	4,545	4,400
Food/Seed/Ind. Use (Mill. Bu.)	2,981	3,488	4,363	5,025	5,961	6,426	6,439	5,937
Fuel Ethanol Use (Mill. Bu.)	1,603	2,117	3,026	3,709	4,591	5,021	5,011	4,550
Est. DDGS Prod. @18 lbs (Mill. Bu. Equiv.)	563	744	1,064	1,304	1,614	1,765	1,762	1,599
DDGS Exports (Mill. Bu. Equiv.)	50	73	161	204	340	340	309	267
Est. DDGS Feed Use (Mill. Bu. Equiv.)	513	671	903	1,100	1,274	1,425	1,452	1,333
Corn + DDGS Feed Use (Mill. Bu. Equiv.)	6,668	6,269	6,841	6,282	6,399	6,218	5,997	5,733
Other Food/Seed/Ind. Use (Mill. Bu.)	1,378	1,371	1,337	1,316	1,370	1,405	1,428	1,387
Corn Exports (Mill. Bu.)	2,134	2,125	2,436	1,849	1,980	1,835	1,543	800
Corn Net Exports (Mill. Bu.)	2,125	2,113	2,416	1,835	1,972	1,807	1,514	675
Total Corn Use (Mill. Bu.)	11,270	11,210	12,737	12,056	13,066	13,054	12,527	11,137
Ending Corn Stocks (Mill. Bu.)	1,967	1,304	1,624	1,673	1,707	1,128	990	758
U.S. Average Farm Price, Corn, $/Bu.	$2.00	$3.04	$4.20	$4.06	$3.55	$5.18	$6.22	$6.90
% Corn Production Used for Fuel Ethanol	14%	20%	23%	31%	35%	40%	41%	42%

In the domestic market, the sharp increases in corn prices after 2007 have led to higher prices for foods that make heavy use of corn. Meat and poultry production has been heavily affected. Higher prices for these commodities have forced price rationing among consumers, and per capita consumption has declined to levels not seen since 1991 (next chart).

The post-2007 decline in U.S. meat and poultry consumption is unprecedented. But, so is the current RFS that reduces this industry's access to its basic feedstock, corn. By encouraging the diversion of corn to ethanol production, even in times when corn production and stocks were dangerously low, the RFS has forced all other users to reduce production to accommodate higher costs. It is no accident that the decline in meat and poultry consumption started in 2008, the first year of the current RFS.

USDA Estimates of Per Capita Total Meat and Poultry Consumption, 1990-2012



Summary: An inflexible RFS has caused high and volatile corn prices. Extremely small carryover stocks in 2010/2011 to 2012/2013 caused corn prices to increase to new record levels. Those higher prices severely rationed both feed use, resulting meat consumption, and exports.

The inflexible RFS impact on corn prices and price volatility was studied by Iowa State University. Not only would corn prices have been lower, price volatility would also have declined. The Babcock and McPhail article cited earlier concluded:

"We examine the marginal effect of ethanol policies such as the RFS mandates and the blending wall on price variability of corn and gasoline. Theoretical and empirical results both suggest that current ethanol policies decrease the price elasticity of demand for both commodities, and therefore increase price variability. An important implication has to do with the policy actions with respect to biofuels and particularly ethanol from corn. Policy actions that result in maintaining or changing the current mandates and/or the blend wall should account for their effect on the price elasticity of demand and price volatility for corn and gasoline markets."

Using a statistical model of gasoline and corn prices the authors ran scenarios with historically low and high crude oil prices, and elimination of the RFS. Corn and gasoline price volatility would be reduced more with low crude oil prices because the incentives to continue ethanol production would be lower in a low energy price environment.

The authors also included elimination of the 10 percent ethanol blend limit (BW, or blend wall, in the table below) in their analysis. That elimination also lowered price volatility, but not by as much as eliminating the RFS in the case of low crude oil prices. "Low" and "High" crude oil prices refer not to a specific price, but the lower and upper ends of the historical range. Gasoline price volatility is also decreased. The results presented in the table below are not surprising. Artificially created, inflexible, demand should increase price volatility.

Price Variability of Corn and Gasoline Under Different Crude Oil Price Scenarios

Scenario	Corn CV	Gasoline CV
High crude oil prices		
RFS, BW, and tax credits	0.2654	0.2365
Elimination of BW	0.2008	0.2180
Elimination of RFS	0.2441	0.2295
Low crude oil prices		
RFS, BW, and tax credits	0.3043	0.2703
Elimination of BW	0.2952	0.2661
Elimination of RFS	0.2497	0.2518

The "CV" is the coefficient of variation. It is the standard deviation of the corn or gasoline price divided by the average of the respective price. As such, it is a measure of the volatility of the prices relative to their averages.

RFS Adjustments for Cellulosic Ethanol

An ambitious RFS schedule and generous tax credits for cellulosic ethanol have completely failed to produce any meaningful amount of fuel. The first commercial scale plants (Poet/DSM and DuPont) are under construction. They are scheduled to come online in 2014. However, they will cost about $500 million to build, and have only 55 million gallons-per-year initial capacity, but only if they operates as designed.

The 2014 cellulosic ethanol RFS calls for 1.75 billion gallons of cellulosic ethanol. The 2014 cellulosic RFS, and all years beyond 2013, is grossly unrealistic.

The 2007 cellulosic RFS was recently examined in great detail by the National Research Council. A broad-based, multi-disciplinary, group of experts concluded that meeting the current cellulosic RFS schedule is highly unlikely. Extraordinary technical barriers to successful commercialization of cellulosic ethanol were described in detail. In addition, the report found significant issues with increased greenhouse gas emission goals, cost-efficient feedstock production, increased competition for food crop land, increased federal subsidy costs, increased water use, and potential air quality degradation.

In light of these recent findings, the EPA should reexamine the 2007 RFS schedule for cellulosic ethanol. Any cellulosic ethanol RFS should reflect the realities of technical barriers, fuel costs, food production, and environmental impact.

In addition to the technical issues with increased cellulosic ethanol production, there is also a major price and competitiveness problem. Corn-based ethanol has already saturated the E10 market. Unless cellulosic ethanol is fully price competitive with gasoline, it will be very difficult to move beyond the current E10 volume ceiling. Simply put, while there is a blending mandate, motorists will not voluntarily buy higher blend levels unless the cost per mile is at least as good as E10. Mandating purchase of a product for which there is no purchase incentive will prove to be very difficult.

The Bottom Line

Despite overwhelming evidence that the inflexible RFS is causing significant economic harm, and few benefits, the EPA refused to grant a RFS waiver in the wake of the 2012 corn crop disaster. The current

waiver system that relies on the judgment of a single political appointee is broken. The conventional biofuel RFS needs to be substantially reformed, or entirely removed.

Appendix: Gasoline Price Models

Model 1, Monthly Gasoline Prices, Crude Oil Prices, Ethanol Production and Other Related Factors:

January, 2000 to December, 2012 monthly average New York harbor conventional gasoline regular spot price FOB (Cents per Gallon) is a function of:

Variable	Coefficient	T
Constant	-92.33935775	-2.326185877
U.S. Crude Oil Composite Acquisition Cost by Refiners (Dollars per Barrel)	2.661642753	45.55229375
U.S. Oxygenate Plant Production of Fuel Ethanol (Million Barrels)	0.075380391	0.20072791
U.S. Percent Utilization of Refinery Operable Capacity (Percent)	1.727789506	4.802931302
U.S. Ending Stocks excluding SPR of Crude Oil and Petroleum Products (Million Barrels)	0.11918305	4.725172965
U.S. Motor Gasoline Ending Stocks (Million Barrels)	-0.824142742	-5.767141876
Net gasoline exports (Million Barrels)	0.04983226	0.210245441
Jan	16.03112208	3.860174213
Feb	17.75201631	4.158569722
Mar	10.5352715	2.686626276
Apr	5.162261127	1.301101864
May	0.958144504	0.229422696
Jun	-5.694714684	-1.330484275
Jul	-9.651037834	-2.192225171
Aug	-10.3360385	-2.133427155
Sep	-1.862283641	-0.430238169
Oct	-8.462763507	-1.926738424
Nov	-6.681878724	-1.671766198
Katrina Effect Sept-Oct 2005	33.33642842	4.296622099
MTBE Effect Apr-Aug 2006	21.5025586	4.493252383
2007 Refinery Outages Mar-Jul 2007	27.25898261	5.653795163

n = 156, Degrees of Freedom = 134, R^2 = 0.987

A “T Statistic” of ±1.98 is required to be statistically significant from zero at the 95 percent level.

Discussion: Except for ethanol production all of the variables are statistically significant and have the expected direction of influence. Ethanol production and net gasoline exports were not statistically significant. The monthly price level seasonal estimates use December as the base month.

Model 2, Monthly 3:2:1 Crack Spread, Crude Oil Prices, Ethanol Production and Other Related Factors:

January 2000 to December 2012 monthly average New York gasoline and heating oil prices and the crude oil composite acquisition cost by refiners were used to compute the 3:2:1 crack spread ($/barrel). The crack spread is modeled as a function of:

Constant	-33.17838042	-2.435228108
U.S. Crude Oil Composite Acquisition Cost by Refiners (Dollars per Barrel)	0.18145835	9.048244859
U.S. Oxygenate Plant Production of Fuel Ethanol (Thousand Barrels)	-4.08342E-05	-0.316811101
U.S. Percent Utilization of Refinery Operable Capacity (Percent)	0.631397725	5.11382022
U.S. Ending Stocks excluding SPR of Crude Oil and Petroleum Products (Thousand Barrels)	3.89383E-05	4.497876255
U.S. Motor Gasoline Ending Stocks (Thousand Barrels)	-0.000282767	-5.765201869
Net gasoline exports (Thousand Barrels)	-1.10472E-05	-0.135798319
Jan	5.30267672	3.720189262
Feb	5.554682218	3.791249947
Mar	2.44603812	1.817404701
Apr	-0.012523	-0.009196162
May	-1.876730705	-1.309285103
Jun	-3.964723245	-2.69884258
Jul	-5.418660026	-3.586162342
Aug	-5.526645823	-3.323626663
Sep	-2.318905977	-1.560893056
Oct	-3.5890465	-2.380765055
Nov	-2.517690736	-1.835296485
Katrina Effect Sept-Oct 2005	12.00910082	4.509677446
MTBE Effect Apr-Aug 2006	6.170663751	3.756898444
2007 Refinery Outages Mar-Jul 2007	8.212864375	4.963088033

n = 156, Degrees of Freedom = 134, R^2 = 0.736

A “T Statistic” of ±1.98 is required to be statistically significant from zero at the 95 percent level.

Discussion: All of the variables have the expected direction of influence. Ethanol production was not statistically significant. Net gasoline exports had a negative, and insignificant, effect on the 3:2:1 crack spread.

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Steptoe
STEPTOE & JOHNSON LLP

April 29, 2013

TO: House Energy and Commerce Committee

FROM: Society of Independent Gasoline Marketers of America

RE: Renewable Fuel Standard Assessment White Paper – Agricultural Sector Impacts

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The Society of Independent Gasoline Marketers of America ("SIGMA") applauds the Energy and Commerce Committee for conducting its review of the renewable fuel standard ("RFS"). SIGMA represents a diverse membership comprised of approximately 260 independent chain retailers and marketers of motor fuel. SIGMA members know first-hand the legal and logistical complexities associated with the RFS, and are pleased to provide answers to the following questions set forth in the Committee's White Paper on the RFS's impact on the agricultural sector. SIGMA has provided answers to only those questions that are pertinent to SIGMA members' operations.

#3 **Was EPA correct to deny the 2012 waiver request? Are there any lessons that can be drawn from the waiver denial?**

As a policy matter, EPA was correct to deny the 2012 waiver request because granting the waiver would have disrupted business decisions premised upon the RFS statutory volume obligations for 2013. A lesson to be drawn from EPA's disposition of the waiver request is that EPA interprets its statutory waiver authority—first in 2008 and reaffirmed in the 2012 waiver denial—in a manner which means a waiver, such as that requested last year, is unlikely to come to pass in the real world.

EPA was correct to deny the 2012 waiver request

If EPA had granted the waiver requests, it would have: 1) had a minimal impact on the amount of ethanol blended and 2) served only to disrupt a marketplace where decisions had already been made assuming the waiver would not occur.

Reducing the 2013 mandate on such relatively short notice would have left existing ethanol facilities with stranded investments that were made based upon a guaranteed level of annual demand. The potential subsequent drop in the price of corn ethanol could also have created havoc in the market.

Granting the waiver also would have adversely affected the market for renewable identification numbers ("RINs"). Indeed, granting the waiver likely would have had a greater impact on RIN prices than corn or ethanol prices. Fuel marketers and retailers had already signed contracts transferring RINs; such contracts would have been disrupted if the waiver had been granted.

Reducing 2013's volume obligations would have had a limited effect on the amount of ethanol blended in the fuel marketplace. Ethanol is currently the lowest cost octane available. As long as ethanol stays below the cost of gasoline, it will be blended whenever possible to generate incremental margin for the blender. Any waiver would not likely decrease the amount of ethanol in the fuel pool simply because other octanes—such as toluene and xylene—are more expensive and have been for most of the last five years.

Finally, because EPA does not have the statutory authority to waive the mandate for more than one compliance year,[1] responsible market participants would have had to plan for a rise in the volume obligations in 2014 (as required under the Clean Air Act), at which point the market will likely have reached the so-called "blend wall," (*i.e.*, whereby obligated parties will not be able to meet their volume obligations with physical blending and will have to turn to the RIN market. Thus, even if the 2013 obligations had been reduced, obligated parties would have been pressured to continue to blend at their then-current rate and simply carry over surplus RINs to offset inevitable deficits in 2014.

<u>Denial of the 2012 waiver request shows such waivers will rarely be granted</u>

EPA's interpretation of its own statutory authority for granting waivers is found in its 2008 denial of the State of Texas's request for a waiver.[2] There, EPA stated that to qualify for a waiver based on severe economic harm, "implementation of the RFS program itself must be the cause of the severe harm" to the exclusion of any additional causes.[3]

Thus, in denying the 2012 waiver requests, EPA cited (among other things) the "context of the current drought and its impacts on corn yields and corn prices."[4] In other words, because the drought inevitably caused at least *a portion* of the economic harm from which the requesting states sought relief, EPA did not have the statutory authority to waive the 2013 volume obligations. It follows that the Agency's position is that it can only grant such waivers when the RFS is the <u>sole</u> cause of the underlying economic hardship.

This interpretation limits EPA's authority to grant waivers for economic hardship. Indeed, economic plight in a modern, interdependent economy inevitably stems from multiple sources. If pressed, one could conceivably conjure up a hypothetical situation in which the RFS and the

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[1] Clean Air Act Section 211(o)(7)(C) ("A waiver granted . . . shall terminate after 1 year, but may be renewed by the Administrator . . . ."
[2] 73 Federal Register 47168 (Aug. 13, 2008).
[3] *Id.* at 47171.
[4] 77 Federal Register 70773 (November 27, 2012).

RFS alone caused economic hardship for which no external forces were in any way remotely responsible. Such an exercise would be frustrating and unpleasant, and is not recommended.

#4. <u>Does the Clean Air Act provide EPA sufficient flexibility to adequately address any effects that the RFS may have on corn price spikes?</u>

The Clean Air Act itself provides EPA sufficient flexibility to adequately address any effects that the RFS may have on corn prices, but the EPA's own interpretation of the Clean Air Act appears to prevent the use of that flexibility. In its denial of the 2008 Texas waiver request, EPA concluded that the plain language of section 211(o)(7)(A) required that the implementation of the RFS *alone* must cause severe economic harm. This is a flawed interpretation of its own statutory authority. However, so long as EPA interprets the statute in this restrictive manner, the Clean Air Act does not provide adequate flexibility.

#6. <u>What role could cellulosic biofuels play in mitigating the potential effects of the RFS on corn prices?</u>

If cellulosic ethanol is produced on a cost-effective basis, *i.e.*, at a cost that is competitive with corn ethanol and gasoline, cellulosic ethanol has the potential to significantly *displace* corn ethanol and thereby help eliminate any RFS effects on corn prices. Under the RFS, cellulosic RINs can satisfy corn ethanol obligations, but corn ethanol RINs cannot satisfy cellulosic obligations. Thus, if it is produced at a price that is equal to or less than corn ethanol, cellulosic ethanol will displace corn ethanol because cellulosic RINs are more valuable. (Indeed, several originators of the RFS intended for this to be the outcome when they developed the program and expanded it in 2007.)

Cellulosic ethanol must also be competitive with gasoline because otherwise no consumers will purchase it. While the RFS contains a number of affirmative obligations on a number of different parties, the RFS does <u>not</u> require consumers to purchase anything. Therefore, unless cellulosic ethanol can be produced on a cost-effective basis, it will never displace gasoline.

Indications are that in order to displace corn ethanol and gasoline, cellulosic ethanol must be produced from feedstocks which produce at least 15 tons of dried biomass per acre. Feedstocks that have currently been approved as "pathways" under the RFS (such that resulting ethanol generates RINs) are incapable of such high-volume cultivation per acre. Unless new feedstocks are approved, cellulosic biofuels will play a minimal role in mitigating the potential effects of the RFS on corn prices.

#8. <u>Will the cellulosic biofuels provisions succeed in diversifying the RFS?</u>

The answer to this question is positively correlated to the answer to the previous question. In other words, if new feedstocks capable of generating cellulosic ethanol on a basis that is competitive with gasoline and corn ethanol are approved as RFS pathways, the cellulosic biofuels provisions will succeed in diversifying the RFS. If, however, such additional pathways are not approved, cellulosic ethanol will not diversify the RFS because consumers will not purchase it at a price that exceeds those of competing products.

* * * * *

SIGMA appreciates the opportunity to provide the foregoing analysis. SIGMA stands ready to assist the Committee in its consideration of policies that will promote a stable and efficient market for transportation fuels.

Respectfully Submitted,

R

R. Timothy Columbus
General Counsel
SIGMA

DCG Public Affairs, LLC

To: Energy and Commerce Committee RFS Review – Agricultural Impacts
From: Dennis Griesing, Principal
Date: April 29, 2013

Re: RFS Impact on Domestic Oleochemical Industry – Cost of "Animal Fats"

Introduction & Overview:

The following comments are submitted on behalf of the oleochemical members of The American Cleaning Institute® (ACI), the trade association representing the $30 billion U.S. cleaning products market. ACI members include the formulators of soaps, detergents, and general cleaning products used in household, commercial, industrial and institutional settings as well as companies that supply ingredients and finished packaging. ACI and its members are dedicated to improving health and the quality of life through sustainable cleaning products and practices, and its mission is to support the sustainability of the cleaning products industry through research, education, outreach and science-based advocacy.

The following briefly outline the background on the industry and policy issues; the economic and jobs impact of problematic U.S. energy policies; and, requested relief via a policy change.

Industry Background and Policy Issues:

The ACI welcomes the opportunity to present comments related to the impact of the RFS2 on agricultural sectors on behalf of its oleochemical-manufacturing members. Domestic oleochemical manufacturers are historic users of "animal fats," an agricultural commodity. Oleochemicals are chemicals made from animal fats and seed oils including fatty alcohols and fatty acids that have wide ingredient application in industrial and consumer products. Oleochemicals are the original "green chemistry" and the domestic oleochemical industry provides direct and indirect employment for an estimated 25,000 people. Oleochemical plants provide union, breadwinner jobs represented by the United Commercial and Food Workers, reflecting the industry's origins in the stockyards of the Mid West, as well as the United Steelworkers Union.

The price of animal fats, a co-product of livestock slaughter, has been significantly impacted by the RFS2 in its establishment of guaranteed markets for categories of biofuels fuels. "Animal fats" provide raw material for traditional biodiesel as well as advanced biofuels. "Animal fats are considered "biomass" for purposes of the RFS2. Oleochemicals have standing in this review because they share a raw material base, i.e., animal fats, with biodiesel and other biofuels.

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Until 2004, the animal fats market was free and open driven by supply and demand. Since then, biofuel producers have received raw material subsidies of $1/gal through tax credits as well as guaranteed markets via the Revised Renewable Fuel Standards (RFS2). Oleochemical producers, to their detriment, receive no such government supports, and as discussed above, they must now compete for raw material against a government-subsidized industry. Raw material prices have more than doubled since 2004. As of April 29, Bleached Fine Tallow was trading at $0.4225 lb. Paradoxically, at current tallow prices, it takes 348.6 lbs. of tallow, at a cost of $148, to make a barrel of biodiesel. At the same time, a barrel of West Texas Intermediate crude is $93 - a $55 difference."

“Animal fats” differ from other biofuel raw materials in that the supply is inelastic. Other cultivated commodities, e.g., soybeans and corn, have the option of increased cultivation in order to offset the higher prices created by biofuel demand. This option is not available for “animal fats” because they are a “co-product” rather than the primary commodity.

A co-product is a derivative of another commodity. In this case, the primary commodity is meat. Cattle are not raised for their fat; they are raised for their meat. As a result, “animal fats” production is driven by meat consumption rather than biofuel demand despite the fact that “animal fats” are increasingly used as a biofuel raw material. The consequence is a commodity price driven upward by government policies resulting in increased demand but without the traditional offsetting capability of increasing supply.

Animal fats provide oleochemical producers a competitive raw material base against foreign palm oil alternatives. If animal fats prices lose their competitive edge, the domestic industry stands to be lost to offshore, foreign competitors. Absent relief, market economics will first drive oleochemical production offshore to be followed by related finished product production.

“Animal fats are also falsely portrayed as “waste.” They are the lifeblood of the domestic oleochemical industry and have historical, well-established uses in other applications as well, including animal feed.

According to the United States Department of Agriculture’s (USDA) Agricultural Marketing Service, inedible tallow traded at $1,097 metric ton in April 2012, up 34% since 2010. The National Renderers Association (Renderers) estimates that 30% of animal fats goes to biodiesel production. In 2011 they report that domestic production of biodiesel was 1.1 billion gallons, a 200% increase over 2010. This is significant in that the tax credit for biodiesel production was suspended for most of 2010. While the tax credit is not the issue before the Committee in this review, it is illustrative of the impacts of government policy on the biofuels market.

Three documents are appended. Appendix A is draft legislation to restore an open and competitive for animal fats. Appendix B is ACI’s is an analysis of the RFS’ impact on oleochemical producers submitted to the Environmental Protection Agency in 2011. Appendix C is a more detailed position paper on the issue.

Summary and Policy Recommendation:

For the foregoing reasons, ACI respectfully urges that “animal fats” be eliminated as a qualifying commodity under the RFS2. This policy change would serve to eliminate the disadvantage currently imposed on oleochemical producers and return the “animal fats” market to its free market origins. “Animal fats” could continue to be used by biofuel producers outside of the RFS2 framework, nevertheless.

Respectfully submitted,

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Encl.

APPENDIX A

Textual Analysis of the Proposed Amendment to Exempt Animal Fats from National Tax Credit and Standards Programs

The proposed amendment would make changes to three statutory provisions relating to federal government policy on renewable energy, two of which provide tax credits for renewable fuels and the other that establishes national renewable fuel standards. Each of the three changes in the amendment would simply exempt fuels derived from animal fats from the application of the credits or the standard. In short, such fuels would not get to take advantage of the tax credits, and biofuel sellers would not be required to use such fuels to meet the standards. The effect of the amendments will be to re-establish a competitive open market for the marketing of the extremely inelastic supplies of animal fats. The amendment would have no adverse effect on the use of expandable agricultural crops to provide feed stocks for biodiesel production. Biofuel producers could continue to purchase animal fats in the reestablished competitive, free and open market.

Subsection (a) of the amendment would amend section 40A of the Internal Revenue Code of 1986 (26 U.S.C. 40A), which provides a $1 per gallon tax credit on the sale of biodiesel, and a 10 cents per gallon credit to small producers of agri-biodiesel (which is defined as diesel derived from virgin plant oils and animal fats).

Subsection (a) would amend the definition of "biodiesel," as used in the section 40A, by adding a caveat at the end of the definition that the term does not include biodiesel derived solely or partially from animal fats. The effect of this change is to bar the granting of the biodiesel tax credit to such biodiesel derived from animal fats.

Subsection (a) would also amend the definition of "agri-biodiesel," as used in the section, by deleting that part of the definition that states that the term means biodiesel derived from animal fats. The effect of this change similarly will bar the granting of the agri-biodiesel tax credit to animal fats-based biodiesel.

Subsection (b) of the amendment would amend section 6426 of the Code (26 U.S.C. 6426), which provides an excise tax credit for renewable fuels, including biodiesel and "alternative fuel" mixtures. With respect to the former—that is, biodiesel—animal fats-based biodiesel would be excluded from the excise tax credit by operation of the change made by subsection (a) of the amendment. This is because paragraph (5) of subsection (c) of section 6426 (which subsection establishes the credit for biodiesel mixtures) provides that, for purposes of the subsection, the terms used therein have the meaning given them in section 40A of the Code.

What subsection (b) does is address the inclusion of animal fats-based liquid fuel in the definition of "alternative fuel" also eligible for an excise tax credit by amending subsection (d) of section 6426, which establishes the alternative fuel credit.

An Internal Revenue Service notice issued in 2007 (Notice 2007-97) states that the term "alternative fuel" includes liquids derived from rendered fat. Under this notice, then, if the animal fats-based liquid fuel is not biodiesel (subsection (d)(1) of section 6426 excludes biodiesel from the definition of "alternative fuel"), the alternative fuel is eligible for the credit. The amendment will revise the definition of "alternative fuel" for purposes of the credit to exclude any liquid fuel derived from animal fat. This change will prevent the award of the excise tax credit for such animal fats-based fuel.

Subsection (c) of the amendment would amend subsection (o) of section 211 of the Clean Air Act (42 U.S.C. 7545), which establishes renewable fuel standards. The current renewable fuel standards are a revision made in 2007 of standards established earlier, and are known by the acronym "RFS2."

Under the RFS2, all biofuels marketed in the United States annually must cumulatively contain the following volumes of biomass-based biodiesel: in 2009, 500 million gallons; in 2010, 650 million gallons; in 2011, 800 million gallons; and in 2012, 1 billion gallons.

Subsection (o) of section 211 defines "biomass-based diesel" to mean renewable fuel that is biodiesel; it defines "renewable fuel" to mean fuel that is produced from renewable biomass; and it defines "renewable biomass" to include "animal waste material and animal byproducts."

The amendment made by subsection (c) would limit the term "animal byproducts" to those byproducts that have no commercial value. The effect of this change is to exclude from the term animal fats used in commerce; and in turn the effect of revised term would be that animal fats would not be considered renewable biomass. With that, biomass-based diesel made from animal fats would not be part of the RFS2.

An Amendment

To exempt animal fats from national renewable energy tax credit and standards programs to ensure that commercial users of these valuable products for purposes other than production of fuel have free-market access to them.

VIZ., at the end of the bill insert the following new section:

"SEC. ____. EXEMPTION OF ANIMAL FATS FROM NATIONAL RENEWABLE ENERGY TAX CREDIT AND STANDARDS PROGRAMS.

"(a) TAX CREDITS FOR BIODIESEL AND RENEWABLE DIESEL USED AS FUEL.—Subsection (d) of section 40A of the Internal Revenue Code of 1986 (26 U.S.C. 40A) is amended by—

"(1) in paragraph (1), adding before the period at the end the following: 'nor biodiesel derived solely or partially from animal fats'; and

"(2) in paragraph (2), striking ', and from animal fats'.

"(b) VOLUMETRIC EXCISE TAX CREDIT FOR ALTERNATIVE FUELS.—Subsection (d)(2)(G) of section 6426 of the Internal Revenue Code of 1986 (26 U.S.C. 6424) is amended by inserting before the period at the end the following: ' except for liquid fuel derived from animal fat'.

"(c) RENEWABLE FUEL STANDARDS.—Subsection (o)(1)(I)(iii) of section 211 of the Clean Air Act (42 U.S.C. 7545) is amended by inserting 'otherwise non-merchantable' before 'animal byproducts'."

Appendix B

VIA ELECTRONIC SUBMISSION

August 11, 2011

Environmental Protection Agency
Air and Radiation Docket and Information Center
Environmental Protection Agency
Mailcode: 2822T
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

RE: Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards:
Docket ID No. EPA–HQ–OAR–2010–0133

The American Cleaning Institute® (ACI, formerly The Soap and Detergent Association, SDA) represents the $30 billion U.S. cleaning products market and includes the formulators of soaps, detergents, and general cleaning products used in household, commercial, industrial and institutional settings; companies that supply ingredients and finished packaging for these products; and oleochemical producers.

We appreciate the opportunity to provide comments on the proposed 2012 Renewable Fuel Standards and the volume requirements for biomass-based diesel in 2013 and beyond. As outlined below, ACI has serious concerns regarding the 2012 Renewable Fuel Standards and 2013 biomass-based diesel volume mandate. The proposal will have a serious and significant impact on ACI member companies' ability to source animal fats for use as an oleochemical feedstock. We respectfully request that EPA use its discretionary authority to lower, rather than raise the volume requirements for biomass-based diesel and advanced biofuel, or, alternatively, to exclude animal fats as a feedstock option. The proposed volumes would divert even larger quantities of a finite inelastic supply of animal fats to the biofuels market, thereby critically disadvantaging the domestic oleochemical industry.

Combined government policies have driven the price of tallow above that of palm oil for the first time in history. More importantly, the proposed rule, with its higher volumes, now threatens the availability of animal fats for use in oleochemicals. Unless these government policies are reversed, the domestic oleochemical industry stands to be driven offshore to Southeast Asia to be near its new raw material source, i.e. palm oil. While it is somewhat difficult to tease out industry specific numbers from the Standard Industry Codes (SIC) or Dunn and Bradstreet, our best estimate is that the oleochemical industry currently directly supports 20,000 breadwinner jobs in the United States.

Executive Summary

- The price of animal fats has dramatically increased under the combined policies of the RFS2 and tax incentives for biofuels
- Biofuel production consumes a significant amount of the total supply of animal fats and current policies threaten not only the price but the availability of animal fats for oleochemical production
- For the first time in history, the price of animal fats now exceeds that of Malaysian palm oil
- Switching to palm oil by the oleochemical industry threatens 20,000 U.S. jobs
- EPA must use all its available discretion to exempt or minimize the use of animal fats under the RFS2 mandates and include the Proposed Rule's impact on the oleochemical industry in its analysis of impacts on other sectors and industries. The EPA must address the potential job loss in collateral industries (Section IV. A of Proposed Rule)
- The use of animal fats to make biodiesel could consume a given year's total supply of animal fat
- Agency mandates should not choose winners and losers. EPA has a responsibility, if not duty, to equally protect all industries that rely on animal fats to produce goods

Market Conditions under 1.0 billion gallon mandate

Since the adoption of federal policies encouraging the use of animal fats as a biofuels feedstock, the price of animal fats has increased significantly. The average yearly price of animal fats (BFT Delivered Chicago) has, as the table below shows, increased from $0.19 in 2006 to $0.44 in 2011.[1]

Table 1.

Average Yearly Price	BFT - Delivered Chicago	Price Change (year to year)	Percent Change (year to year)
2006	$0.19	N/A	N/A

[1] *The Jacobsen; 2011 data is 6 month average (January through June 2011).*

2007	$0.28	$0.09	50.5%
2008	$0.34	$0.06	23.2%
2009	$0.25	-$0.09	-26.6%
2010	$0.33	$0.08	32.6%
2011 (Jan-June)	$0.44	$0.11	32.4%

Source: The Jacobsen

During this same period (2006-2010) domestic production of rendered products has generally trended downward from a 2006 level of 4,534.9 metric tons to 4,264.5 metric tons in 2010, a reduction of 270.4 metric tons.[2] Unlike other commodity markets, where higher prices lead to greater supply, animal fats operate in an inelastic market.

Table 2.

U.S. Production of Rendered Products (000 Metric Tons)	**2006**	**2007**	**2008**	**2009**	**2010**
Inedible tallow and greases (total):	2963.8	3006.5	2880.8	2821.5	2668.1
Inedible tallow	1737.8	1727.5	1610.7	1531.1	1511.2
Greases	1226.0	1279.0	1270.1	1290.3	1156.9
Yellow grease	671.4	700.0	769.1	740.3	569.2
Other grease	554.6	579.0	501.1	550.0	588.3
Edible tallow	844.3	811.4	813.7	833.4	827.6
Lard	143.8	211.2	222.6	157.0	130.4
Poultry fat	583.0	624.8	659.3	625.4	638.3
Subtotal	**4534.9**	**4653.9**	**4576.4**	**4437.3**	**4264.5**
Year to Year Difference	**N/A**	**119.00**	**-77.50**	**-139.10**	**-172.80**
Percent of Supply Change	**N/A**	**2.56**	**-1.69**	**-3.13**	**-4.05**

Source: Render Magazine, April 2009 and April 2011

The supply of animal fats is inelastic.

At the same time that the RFS2 mandates have been implemented for biomass-based diesel, the supply of animal fats has fallen 8.3% from 2007-2010. The decline stems from many factors, including an economic downturn that caused consumers to decrease their consumption of beef products. Livestock owners also decreased their herds as the cost of production increased due to higher feed prices, driven in part by corn ethanol. This has led to fewer animals being brought to market. Livestock production is geared to food supply, not fuel. Animal fats are a co-product of livestock slaughter, not a demand driver. Consequently, there is no reasonable prospect that production will increase significantly, farmers and ranchers do not raise or slaughter animals for their fats.

[2] *Render Magazine, April 2009 and April 2011*

Historically, animal fats have provided domestic oleochemical producers a competitive raw material cost advantage over foreign-sourced palm. As a result of the RFS2 mandates as well as tax credits that support diversion of animal fats to biofuel production, that raw material price advantage has now been lost for the first time (see Graph 1). Oleochemicals are the original "green" chemistry. They are used in a wide range of value-added household and industrial products. In view of this history, any characterization of animal fats as "waste" is false. Waste implies something that does not otherwise have a value. This is not the case with animal fats. Papers of record, such as the *Wall Street Journal* and *New York Times*, list the commodity prices of the various animal fats used for production in hundreds of products. These prices are also the collected and published by private firms such as ICIS-LOR and The Jacobsen Letter.

Supply shortages lead to raw material price increases.

As noted above, in 2011 the price of tallow has increased $0.11 to $0.44 from an already high price of $0.33 in 2010.[3]

Table 3.

Average Yearly Price	BFT - Delivered Chicago	Soyoil Crude Degummed - Illinois	**BFT - Soyoil Crude Degummed**	Technical Tallow (Cents/Lb)	Palm Stearin FOB Malaysia (Cents/Lb)	**Technical Tallow - Palm Stearin**
2006	$0.19	$0.27	**-$0.09**	$0.19	$0.20	**-$0.01**
2007	$0.28	$0.35	**-$0.08**	$0.29	$0.33	**-$0.03**
2008	$0.34	$0.50	**-$0.16**	$0.37	$0.37	**$0.00**
2009	$0.25	$0.33	**-$0.08**	$0.28	$0.28	**$0.00**
2010	$0.33	$0.39	**-$0.06**	$0.36	$0.39	**-$0.03**
2011 (Jan-June)	$0.44	$0.50	**-$0.06**	$0.53	$0.49	**$0.04**

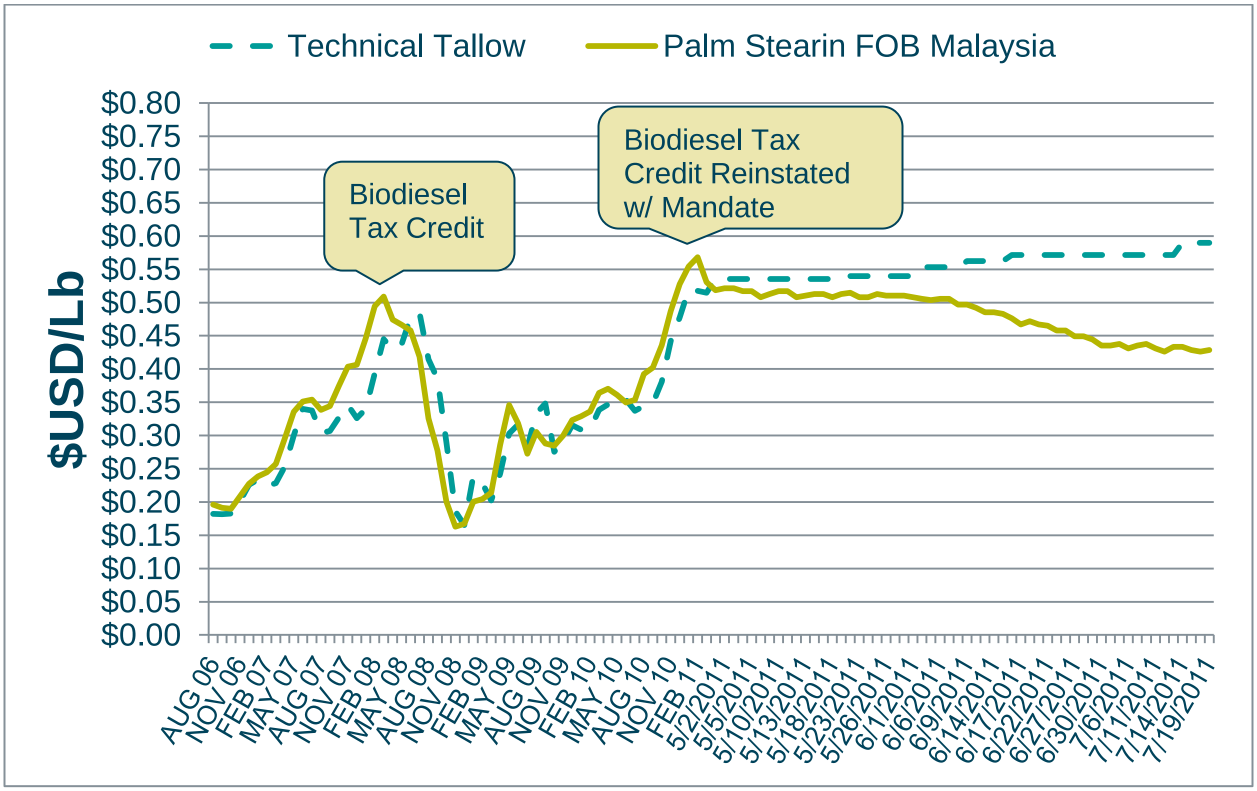
Source: The Jacobsen

The effect the RFS2 mandate and the $1.00 per gallon biodiesel and renewable diesel tax credits have had on the prices for animal fats and palm oil is shown in the table above and more dramatically on the graph below. A guaranteed market combined with a tax credit, has made the price of Malaysian palm oil cheaper than animal fats i.e. technical tallow, for the first time. This foreign material source has become less expensive, thus making it an attractive alternative in product formulation. The price difference is a direct result of policies that have been created to entice and encourage the production of biodiesel and renewable diesel, at the expense of the domestic oleochemical industry.[4] The fact is that the higher prices caused by increased demand for animal fats cannot be offset by increased supply. This is the inelastic economic dilemma for oleochemical manufacturers.

[3] *Source: The Jacobsen*

[4] *Ibid.*

Graph 1.



Source: The Jacobsen

The domestic oleochemical industry has traditionally maintained its production facilities near its raw material source. When these producers switch to a foreign-sourced palm oil, it will likely cause them to move their production facilities offshore. Should the switch from animal fats to palm oil occur, 20,000 jobs stand to be lost, further exasperating current economic conditions.

Animal Fats vs. Soyoil

With respect to biodiesel production, soyoil is a more expensive feedstock option than animal fats. This is shown above in table 3 and on graph 2.[5] Initially, many biodiesel facilities were built to operate using only one feedstock, e.g., soyoil. However, to provide more flexibility and the ability to use cheaper animal fats, many biodiesel producers now have multiple material facilities that can use either soy and animal fats.

Under the RFS2, there is no mechanism or trigger that limits the amount of animal fats that can be used as a biofuels feedstock. The proposed rule references information received from a large rendering company

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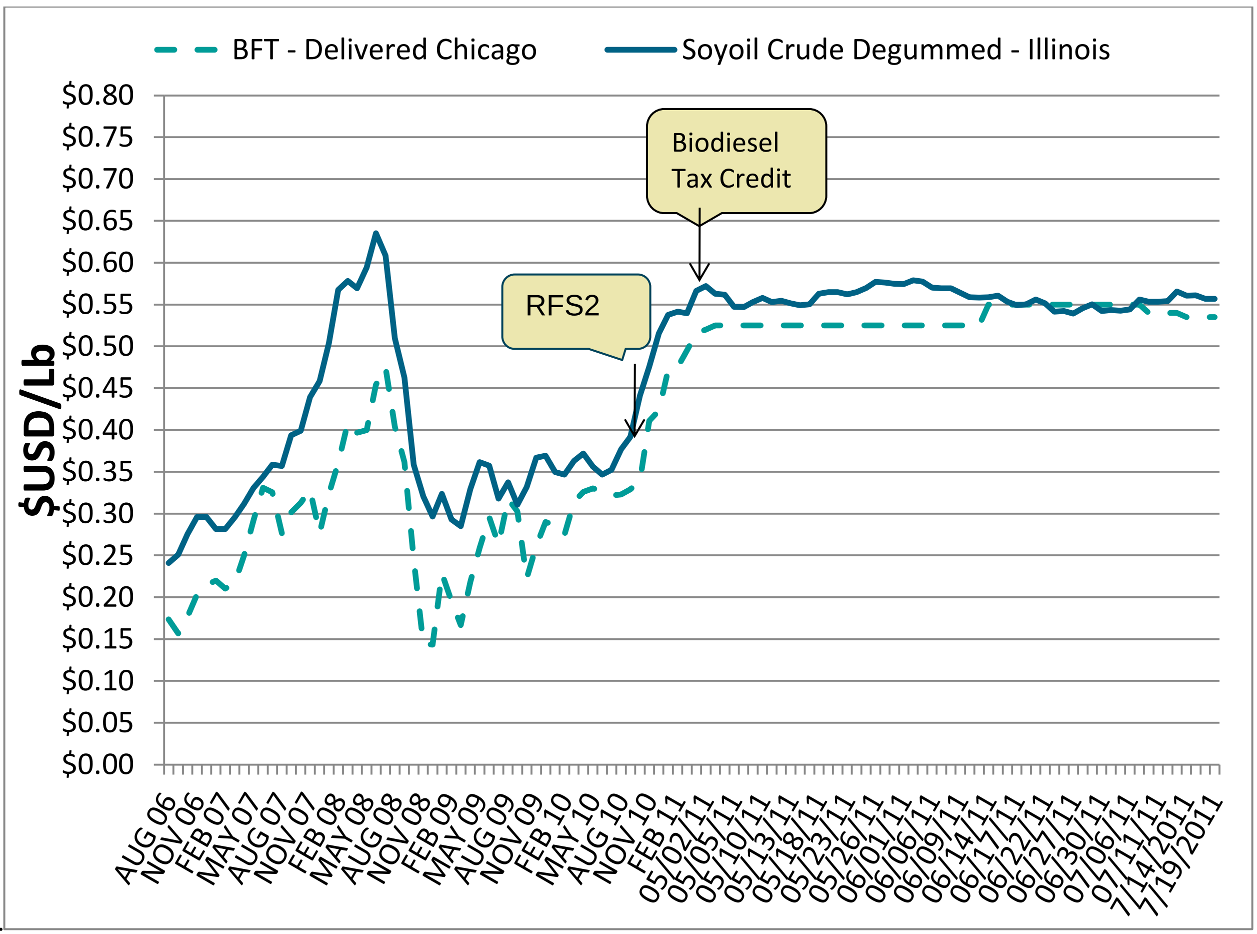
[5] *Source: Ibid*

"suggesting that there will be adequate fats and greases to supply biofuels production as well as other historical uses." (pg. 38857) Yet, at the same time, the proposed rule references projections by the Department of Agriculture that "while over 400 million gallons of biodiesel will be produced from soybean oil in 2010", most of the remaining needed to meet the 1 billion gallon mandate will use animal fats or recycled greases. (pg. 38856) Further, the Agriculture Marketing Resource Center at Iowa State University projects more growth in non-soy oil feedstock volumes than soy oil. (pg. 38856) EPA also anticipates renewable diesel contributing toward the requirements for biomass-based diesel, which will intensify the pressures placed on the animal fats supply. As the following demonstrates, animal fats prices have risen with soyoil and their use continues to be advantageous for biodiesel producers.



Graph 2.

Source: The Jacobsen

Expansion of RFS2 Mandate Compounds Animal Fats Crisis: 7.5 pounds = 1 gal Biodiesel[6]

[6] *Collins, Hal. Soil Scientist/Microbiologist, Vegetable and Forage Research Unit USDA-ARS, Prosser, WA* *http://www.whitman.wsu.edu/documents/USDAARSCollinsPpt.pdf*

The market conditions outlined earlier do not take into account the effect the proposed 2012 requirement of 1.0 billion gallons or the 2013 proposed requirement of 1.28 billion gallons will have on the cost and availability of animal fats. Of further concern is EPA's proposed decision not to lower the advanced fuel mandate, based on the premise that biomass-based diesel, renewable diesel and other biofuels could fill the gap.

In 2009, when the Statute called for 0.5 billion gallons of biomass-based diesel, the Energy Information Administration (EIA) reported that 1.04 billion pounds of animal fats were used as inputs to biodiesel production.[7] Those 1.04 billion pounds of animal fats created approximately 186,666,667 gallons of biodiesel.[8] Total production of rendered products for that year was 4,437.3 (000 Metric Tons) or 9,782,571,951.73 pounds.[9]

10.6% of the supply of rendered products was used to produce 2009's biodiesel fuel.[10] There is nothing in EISA or the proposed rule that limits the amount of animal fats that can be used to meet the mandate. The usage of animal fats could range up to 100%. With no mechanism to limit the usage amount of any feedstock, had 100% of the 0.5 billion gallons been met through animal fats, 3.75 billion pounds of animal fats would have been used, taking 38% of all animal fats out of the market place.

Table 4.

U.S. Production of Rendered Products (000 Metric Tons)	**2009**	**2010**
Inedible tallow and greases (total):	2821.5	2668.1
Inedible tallow	1531.1	1511.2
Greases	1290.3	1156.9
Yellow grease	740.3	569.2
Other grease	550.0	588.3
Edible tallow	833.4	827.6
Lard	157.0	130.4
Poultry fat	625.4	638.3
Subtotal	**4437.3**	**4264.5**
Year to Year Difference	**-139.10**	**-172.80**
Percent of Supply Change	**-3.13**	**-4.05**

Source: Render Magazine, April 2011

Table 5.

	2009	**2010**

[7] *U.S. Energy Information Administration/Monthly Biodiesel Production Report, Table 3. Inputs to Biodiesel Production, January through December 2009.*

[8] *7.5 pounds of animal fats create 1 gallon of biodiesel. Collins, Hal. Soil Scientist/Microbiologist, Vegetable and Forage Research Unit USDA-ARS*

[9] *1 metric tons = 2,204.62262 pounds; 4,437.3 Metric Tons (000) = 4,437,300 x 2,204.62262 = 9,782,571,951.726 pounds.*

[10] *1.04 billion pounds used/9.78 billion pounds total productionx100=10.6% of 2009 production of rendered products.*

U.S. Production of Rendered Products (Pounds)		
Inedible tallow and greases (total):	6,220,342,722.33	5,882,153,612.42
Inedible tallow	3,375,497,693.48	3,331,625,703.34
Greases	2,844,624,566.59	2,550,527,909.08
Yellow grease	1,632,082,125.59	1,254,871,195.30
Other grease	1,212,542,441.00	1,296,979,487.35
Edible tallow	1,837,332,491.51	1,824,545,680.31
Lard	346,125,751.34	287,482,789.65
Poultry fat	1,378,770,986.55	1,407,210,618.35
Subtotal	**9,782,571,951.73**	**9,401,613,162.99**
Year to Year Difference	**-306,663,006.44**	**-380,958,788.74**
Percent of Supply Change	**-3.13**	**-4.05**

Source: Render Magazine, April 2011

In 2010 the production of biomass-base diesel requirement increased to 0.65 billion gallons. Using the same assumptions and calculations, 4.875 billion pounds of animal fats could have been consumed for biodiesel, equaling nearly 52% of that year's total supply of rendered fats.

The 2013 volume of 1.28 billion gallons is expected to be met through the use of 2.85 billion pounds of animal fat. This represents 30% of the entire mandate and is also 30% of the entire production of animal fats in 2010.[11]

Table IV.B.2-1
Feedstocks Contributing to 2013 Volume of 1.28 billion gallons

Source	**Volume (gal)**	**Potential Pounds Tallow**
Yellow grease and other rendered fats	380,000,000	2,850,000,000 (30% of mandate)
Corn oil	300,000,000	
Virgin vegetable oil	600,000,000	
Total	1,280,000,000	9,600,000,000 (100% of mandate)

Source: EPA Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards

When using the IHS Global Insight Modeling, 20% of the mandate depends on 2.04 billion pounds of animal fats and an additional 1.387 billion pounds could be used to achieve 1.3 billion gallons, a potential total of 3.427 billion pounds, which would equal 36% of the entire production of animal fats in 2010.[12]

Table IV.B.2-2
Feedstocks Contributing to 2013 Volume of 1.3 bill gal from IHS Global Insight Modeling

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[11] *30% feedstocks = 2.85 billion pounds used/9.4 billion pounds total production (2010)x100.*
[12] *36% feedstocks = 3.427 billion pounds used/9.4 billion pounds total production (2010)x100.*

Source	Volume (gal)	Potential Pounds Tallow
Yellow grease and other rendered fats	272,000,000	2,040,000,000 (20% of mandate)
Corn oil	185,000,000	
Soybean oil	624,000,000	
Canola oil	68,000,000	
Palm oil	7,000,000	
Other	185,000,000	1,387,500,000 (13% of mandate)
Total	1,340,000,000	10,050,000,000 (100% of mandate)

Source: EPA Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards

Using these models, 30 and 36% of total production of animal fats shows the dramatic increase the RFS2 mandate has had on the supply of animal fats from 2009 when 10.6% of the total production was used.

Table IV.E-1 in the proposed rule provides projections of biomass-based diesel after 2012 (bill gallons). Below is a copy of that table and the potential impact these mandated fuel amount would have on the supply of animal fats.

Table IV.E-1

Projections of biomass-based diesel after 2012 (gallons)

Year	RFS2 Final Rule	Potential Pounds Tallow	IHS Global Insight Report	Potential Pounds Tallow
2013	1,280,000,000	9,600,000,000	1,340,000,000	10,050,000,000
2014	1,390,000,000	10,425,000,000	1,500,000,000	11,250,000,000
2015	1,530,000,000	11,475,000,000	1,810,000,000	13,575,000,000
2016	1,560,000,000	11,700,000,000	2,180,000,000	16,350,000,000
2017	1,600,000,000	12,000,000,000	2,530,000,000	18,975,000,000
2018	1,640,000,000	12,300,000,000	2,740,000,000	20,550,000,000
2019	1,680,000,000	12,600,000,000	3,000,000,000	22,500,000,000
2020	1,720,000,000	12,900,000,000	3,140,000,000	23,550,000,000
2021	1,770,000,000	13,275,000,000	3,230,000,000	24,225,000,000
2022	1,820,000,000	13,650,000,000	3,300,000,000	24,750,000,000

Source: EPA Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards

In 2009 1.040 billion pounds of animal fats were used to help meet that year's 0.5 billion gallon mandate. A mandate of 1.72 billion gallons could use anywhere from 3.536 billion to 12.9 billion pounds of animal fats.[13] The conservative estimate of 3.536 billion pounds assumes that the percentage animal fats used in the production of biofuels remains at that 2009 level.

If the 2013 biodiesel mandate was in effect in 2009, the 3.536 billion pounds of animal fats would equal 36% of that year's supply of rendered products. If the same mandate were in effect in 2010, it would have used 38% of that year's total supply.

Should Biomass-Based Biodiesel producers use only animal fats, the demand would greatly exceed the supply of that material. The use of only animal fats would mean 12.9 billion pounds of animal fats went into the production of biofuels, which is 3.2 billion more pounds than the total U.S. production of rendered products in 2009 and 3.5 billion pounds more than were produced in 2010. Without a mechanism that prevents the mandate to be filled from biodiesel solely produced from animal fats, the total animal fats supply could be completely consumed by biofuel producers.

2013 call for 30% and 36% of biofuels to come from animal fats

The 2013 projection of feedstocks that would be needed to meet that year's 1.28 billion gallon mandate relied on 30% of the total to be derived from animal fats. That increases to 36% using the IHS Global Insights Report. If that occurs, 38% of the animal fats supply would go to the production of biodiesel and should other feedstocks fall short, 100% of the total supply of animal fats could be used to make up the difference.

Table IV.E**:** Projections of biomass-based diesel after 2012 (gallons)
EPA Modeling

	RFS 2 Final Rule	**Potential Pounds Tallow**	**30% usage of animal fats modeling from 2013 projections**	**Potential Pounds Tallow**
2013	1,280,000,000	9,600,000,000	384,000,000	2,880,000,000
2014	1,390,000,000	10,425,000,000	417,000,000	3,127,500,000
2015	1,530,000,000	11,475,000,000	459,000,000	3,442,500,000
2016	1,560,000,000	11,700,000,000	468,000,000	3,510,000,000
2017	1,600,000,000	12,000,000,000	480,000,000	3,600,000,000
2018	1,640,000,000	12,300,000,000	492,000,000	3,690,000,000

[13] *3.536 billion = 17.2/0.5 =3.4; 3.4 * 1,040,000,000 pounds (2009 usage) = 3,536,000,000*

2019	1,680,000,000	12,600,000,000	504,000,000	3,780,000,000
2020	1,720,000,000	12,900,000,000	516,000,000	3,870,000,000
2021	1,770,000,000	13,275,000,000	531,000,000	3,982,500,000
2022	1,820,000,000	13,650,000,000	546,000,000	4,095,000,000

Source: EPA Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards

Table IV.E-1: Projections of biomass-based diesel after 2012 (gallons)

IHS Global Insights Report Modeling

	RFS 2 Final Rule	**IHS Global Insight Report**	**Potential Pounds Tallow**	**36% usage of animal fats modeling from 2013 projections**	**Potential Pounds Tallow**
2013	1,280,000,000	1,340,000,000	10,050,000,000	482,400,000	3,618,000,000
2014	1,390,000,000	1,500,000,000	11,250,000,000	540,000,000	4,050,000,000
2015	1,530,000,000	1,810,000,000	13,575,000,000	651,600,000	4,887,000,000
2016	1,560,000,000	2,180,000,000	16,350,000,000	784,800,000	5,886,000,000
2017	1,600,000,000	2,530,000,000	18,975,000,000	910,800,000	6,831,000,000
2018	1,640,000,000	2,740,000,000	20,550,000,000	986,400,000	7,398,000,000
2019	1,680,000,000	3,000,000,000	22,500,000,000	1,080,000,000	8,100,000,000
2020	1,720,000,000	3,140,000,000	23,550,000,000	1,130,400,000	8,478,000,000
2021	1,770,000,000	3,230,000,000	24,225,000,000	1,162,800,000	8,721,000,000
2022	1,820,000,000	3,300,000,000	24,750,000,000	1,188,000,000	8,910,000,000

Source: EPA Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards

Discretion must be applied

Long term usage and reliance on animal fats to produce biofuels is not viable. There simply is not enough production volume to meet the growing demand for biodiesel and there is little likelihood that the supply of animal fats will increase. Eventually biodiesel producers will have to use feedstocks other than animal fats. This inevitability should cause EPA to exclude their usage in 2012 and beyond to drive the use of more sustainable feedstock supplies. This would go a long way toward protecting the continued viability of the U.S.-based oleochemical industry. Without a consistent and adequate supply of animal fats as a feedstock for the production of oleochemicals, the industry will need to turn to other non-US sourced feedstocks, which over time could result in the US losing this industry.

EPA must use its discretionary authority to ensure adequate supply of these feedstocks for all industries, not just biofuels. EPA should limit the percentage of animal fat supply that can be used in the production of biofuels or eliminate animal fats as a feedstock option. It is unfair to place such a heavy burden on a source that is as inelastic as animal fats. By doing so, EPA is deciding which industry wins and which one loses. The domestic oleochemical industry has provided decades of economic strength and security. Consequently, we urge the EPA to maximize the use its discretion to limit, rather than expand the use of animal fats under the RFS2. The future of a longstanding domestic industry is at stake.

Respectfully submitted,

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Appendix C

Proposed Critical Amendments

To

United States Biofuels Policy

To Preserve the United States' Oleochemical Industry

Oleochemicals

Oleochemicals are the original "green chemistry." They are chemicals made from animal fats and seed oils, including fatty alcohols and fatty acids. Oleochemicals are used as ingredients in cleaning products as well as many other industrial and consumer products.

Issue:

Oleochemicals are impacted by federal biofuels policy because they share a raw material base, i.e., animal fats, with biodiesel and other biofuels. Until 2004, the animal fats market was free and open, driven by supply and demand. Since then, biofuels producers and others have received raw material subsidies of up to $1/gal through tax credits as well as guaranteed markets via the Renewable Fuel Standards and its latest revisions (RFS2). Oleochemical producers, to their detriment, receive no such government supports. Oleochemical producers must now compete for raw material against a government-subsidized industry. Raw material prices have more than doubled since 2004.

Animal fats provide a competitive raw material base against foreign palm oil alternatives. If animal fats prices lose their competitive edge, the domestic industry stands to be lost to offshore, foreign competitors. Absent relief, market economics will first drive oleochemical production offshore to be followed by related finished product production. Animal fats are falsely portrayed as "waste." They are the lifeblood of the domestic oleochemical industry and have historical, well-established uses in other applications as well, including animal feed.

While it is somewhat difficult to tease out industry specific numbers from the Standard Industry Codes (SIC) or Dunn and Bradstreet, our best estimate is that the oleochemical industry directly supports 20,000 jobs in the United States. Oleochemical plants provide union, breadwinner jobs represented by the United Commercial and Food Workers, reflecting the industry's origins in the stockyards of the Mid West, as well as the United Steelworkers Union.

Remedy Sought

Eliminate all tax credits related to the energy use of "animal fats" including the biodiesel tax credits, all other biofuel credits, e.g., renewable diesel, as well as the alternative fuel tax credit for direct burning. Eliminate animal fats–based biofuels from qualification under the RFS2.

Result of Proposed Amendments

The market for animal fats would once again become free, open and competitive. Oleochemical and biofuels producers would purchase animal fats at competitive, open market prices. Oleochemical producers will no longer be in competition with their own government.

Background

Legislative History

Animal fats used for biodiesel, renewable diesel, advanced biofuels and renewable biomass fuels[14] are incentivized by the "American Jobs Creation Act of 2004" and other laws by tax credits of up to $1/gal. Biodiesel markets are also guaranteed by the mandates contained in the Revised Renewable Fuel Standards (RFS2) established by the "Energy Independence and Security Act of 2007" (Public Law No. 110-140). The RFS2's mandated markets compound the situation by allowing biofuels producers to purchase their raw materials at any price since they can charge what is necessary to cover their costs because the mandated volumes of the product must be purchased by blenders.

These two principal statutes have caused the price of tallow to effectively double over pre-incentive, historical prices. This poses a serious problem. The animal fats supply is inelastic, generally varying no more than 2% per annum. Livestock are not grown for their fat. Consequently, animal fats, as well as other non-food portions of the livestock, are known as "co-products" of the slaughter.

Animal Fats are Not Waste

Animal fats have historically been used to a very high degree in various applications. Any characterization of animal fats as "waste" flies in the face of reality. Waste implies something that does not otherwise have a value. This is clearly not the case with animal fats. The Wall Street Journal and New York Times do not publish commodity prices for useless material. If you want to know the commodity prices for various grades of tallow or pork fat etc., you just have to open one of these or other papers of record. These prices are also the collected and published by private firms such as The Jacobsen Letter.

Proposed Remedies

Eliminate Animal Fats from Biofuels Excise Tax Credits

[14] *In some instances, the same animal fats-based biodiesel (methyl ester biodiesel) is referred to by different terms despite being the same product.*

This would have the effect of shifting all subsidies to expandable agricultural crops, e.g., soybeans. Animal fats prices would once again be determined by free market conditions as they were prior to 2004. The exemption should include the Alternative Fuel Tax as well as the biofuels excise tax credits.

Amend RFS2 Biofuel Mandate

The RFS2 threatens both supply and price. The mandated volume levels of the RFS2 assure biofuels producers a market regardless of cost or price. They can pay whatever is necessary for raw materials, thereby inflating animal fats prices beyond the oleochemical industry's ability to compete, because their market is guaranteed. As noted above, once the price of animal fats is inflated beyond that of palm oil, the domestic oleochemical industry will have reached the tipping point of economic sustainability. ACI proposes the following to address the inequities posed by the RFS2 volume mandates:

Exclude Fats and Greases from Definition of "Renewable Biomass"

The definition of "renewable biomass" includes "Animal waste material and animal byproducts." Animal byproducts, e.g., fats and greases, have long, well-established markets in oleochemicals as well as pet foods and other applications. While in general, all the other stipulated constituents of "renewable biomass" are either expandable crops or genuine waste products without pre-existing markets; animal-fats and greases are traded as commodities, have a recognized economic value, are a critical raw material for an existing industry and are not an expandable supply. Neither are they wastes: the price per barrel for tallow is similar to and at times higher priced than a barrel of crude oil. ACI believes that reconsideration of their inclusion ought to be undertaken. They ought not to be included in this definition.

A precedent for such consideration is found at Section 932(a)(C)(i) of the "Energy Policy Act of 2005." In defining biomass derived from "forest-related" materials the phrase "…or otherwise non-merchantable material" is applied. The clear implication of this is that material which otherwise has a market is excluded from the definition. ACI would respectfully urge that similar language be included in the current "renewable biomass" definition.

Eliminate Alternative Fuel Tax Credits for Direct Burning of Animal Fats

The alternative fuel tax credit currently applies to the direct burning of fats in boilers and other stationary facilities. Such burning was a longstanding practice prior to the subsidy and based on market prices for fuels and fats. As such, it was a practice analogous to the burning of "black liquor" by the paper industry. Consequently, it ought to be eliminated as well.

Legislation to accomplish these changes is attached as well. The proposal is based on existing exemptions found in related statutes that already account for the diversion of essential raw materials from historical uses to biofuel production.

The Grocery Manufacturers Association
1350 I Street, NW, Suite 300
Washington DC 20005

April 29, 2013

Rep. Fred Upton
Chairman,
House Committee on Energy & Commerce
2125 Rayburn House Office Bldg.
Washington, DC 20515

Dear Mr. Chairman,

Re: Comments of the Grocery Manufacturers Association on the Committee on Energy & Commerce's Request for Comment on Renewable Fuel Standard Assessment White Paper.

Based in Washington, D.C., the Grocery Manufacturers Association (GMA) is the voice of more than 300 leading food, beverage and consumer product companies that sustain and enhance the quality of life for hundreds of millions of people in the United States and around the globe. Founded in 1908, GMA is an active, vocal advocate for its member companies and a trusted source of information about the industry and the products consumers rely on and enjoy every day. The association and its member companies are committed to meeting the needs of consumers through product innovation, responsible business practices and effective public policy solutions developed through a genuine partnership with policy makers and stakeholders. In keeping with its founding principles, GMA helps its members produce products through a strong and ongoing commitment to scientific research, testing and evaluation and to providing consumers with the products, tools and information they need to achieve a healthy diet and an active lifestyle. The food, beverage and consumer packaged goods industry in the United States generates sales of $2.1 trillion annually, employs 14 million workers and contributes $1 trillion in added value to the economy every year.

Many of GMA's member companies are directly and significantly impacted by escalating commodity prices caused by the Renewable Fuels Standard (RFS). GMA has long opposed food-based renewable fuels and predicted the long term impact the law would have on commodity prices. Although GMA continues to support reform, the association is concerned that reforms that target one feedstock over another, corn or soy, will only shift the cost burden between commodities. It is GMA's preference that Congress address the underlying mandate as a whole and eliminate the government sanctioned market distortions that continue punish consumers with higher food prices.

Commodity Prices

Implementation of the RFS has had profound impacts on the economy and the structure of markets in energy, agricultural commodities, and food manufacturing. These market shifts caused by the RFS have been recognized in numerous studies.[1] Within the agricultural sector, for instance, the National Research Council concluded in 2008 that, "Unless there are major increases in agricultural yields or improvements in the efficiency of converting biomass to fuel, an additional 30 to 60 million acres of cropland would be required to produce enough biomass to meet the Renewable Fuel Standard in 2022. Therefore, increasing biofuels production to meet the RFS consumption mandate is expected to create competition among different land uses…"

This competition has borne out in reality. Since 2005, there have been fundamental shifts in the amount of acreage devoted to corn versus other agricultural commodities, with corn acreage increasing from 81,779,000 acres planted in 2005 to an expected 97,300,000 acres in 2013. By

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[1] Elam, Thomas. *The RFS, Fuel and Food Prices, and the Need for Statutory Flexibility*. Rep. FarmEcon LLC, 16 July 2012. Web. 5 Sept. 2012. http://www.nationalchickencouncil.org/wp-content/uploads/2012/07/RFS-issues-FARMECON-LLC-7-16-12-FINAL.pdf.

Durham, Chris, Grant Davies, and Tanya Bhattacharyya. *Can Biofuels Policy Work for Food Security?: An Analytical Paper for Discussion*. Rep. Department for Environment Food and Rural Affairs U.K., June 2012. Web. 4 Sept. 2012. <http://www.defra.gov.uk/publications/files/pb13786-biofuels-food-security-120622.pdf>.

Carter, Colin, Gordon Rausser, and Aaron Smith. *The Effects of the U.S. Ethanol Mandate on Corn Prices*. Rep. University of California at Davis and University of California at Berkeley, Aug. 2012. Web. 4 Sept. 2012. <http://agecon.ucdavis.edu/people/faculty/aaron-smith/docs/Carter_Rausser_Smith_Ethanol_Paper_submit.pdf>.

Whitacare, Paula, ed. *Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy*. Rep. Washington, DC: National Academies, 2011. Print.

comparison, the acreage planted with the next two biggest crops, soybean and wheat, stayed flat. Despite these large increases in acres planted with corn, 40 percent of production acreage planted is devoted to ethanol production.[2] As a result of these shifts in available supply to the non-ethanol market, commodity prices have risen steeply. From 2005 through 2011, the price of corn rose by 306 percent; soybean rose by 210 percent; and wheat rose by 221 percent. By comparison, in the 10 years prior to implementation of the RFS, corn, soy, and wheat *decreased* by 45 percent, 18 percent, and 30 respectively.[3]

According to a 2011 study by the University of California Davis and Berkeley, the RFS is causing 15 percent of global corn production to be used for ethanol. The study found that the price of corn was 30 percent higher with the RFS from 2006-2010 than it would have been without the mandate.[4] The available supply and price of corn, as well as the other affected commodities, has an enormous impact on the cost inputs to food production. A basic tenet of economics is that cost inputs are passed on in the form of some combination of higher prices, reduced shareholder value and/or reduced production. Corn is a major cost input of our food supply and affects many items consumers purchase. Many foods contain corn starch or corn directly. Moreover, soft drinks and food products contain corn sweeteners. Additionally, grains – specifically corn – dominate the cost structure of the livestock industry. Feed is the major cost input of products such as meat, dairy and eggs; and in 2011 represented 69 percent of the total costs.[5] If price increases are too large, otherwise financially sound operations can become marginal or forced to slaughter their animals and shutter their doors. For instance, between

[2] Davis, Todd. *July 2012-Crop Market Update*. Rep. American Farm Bureau Federation, Aug. 2012. Web. 5 Sept. 2012. http://www.in.nrcs.usda.gov/JUL%2012%20-%20Crop%20Market%20Update.pdf.

[3] "Statistics by Subject." *NASS.USDA.gov*. National Agricultural Statistics Service, 10 Sept. 2012. Web. 10 Sept. 2012. <http://www.nass.usda.gov/Statistics_by_Subject/index.php>.

[4] Carter, Colin, Gordon Rausser, and Aaron Smith. *The Effects of the U.S. Ethanol Mandate on Corn Prices*. Rep. University of California at Davis and University of California at Berkeley, Aug. 2012. Web. 4 Sept. 2012. <http://agecon.ucdavis.edu/people/faculty/aaron-smith/docs/Carter_Rausser_Smith_Ethanol_Paper_submit.pdf

[5] Whitacare, Paula, ed. *Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy*. Rep. Washington, DC: National Academies, 2011. Print. P134.

2008 and 2011, one third of the broiler industry experienced bankruptcy, sale or closure.[6] This tracks closely with rising feed costs of production. From 2005 to 2012, the cost of feed rose from $156 to $335 per ton.[7] Since then, corn prices have soared another 33 percent.[8] The economic importance of this industry cannot be understated. Farm cash receipts from these animals and their products are forecast at $165.8 billion in 2012 – 43% of all agricultural revenue.

The net result of these structural changes in the market brought about by the RFS is examined in a study by Thomas Elam of FarmEcon, LLC, finding significant impacts that are driving up food prices. Corn, ranked by wholesale value dwarfs the second and third ranking commodities, soybean and wheat combined. According to the study, "By 2011, the annual cost of the three commodities to U.S. food producers had risen from $26.5 billion in 2005 to $69.4 billion. The cumulative cost increase over the 2005-2011 was $141.9 billion. So, whereas overall price inflation of items other than food including energy declined dramatically after December 2007, food inflation accelerated.

The United Nations Conference on Trade and Development has also looked at the impact of biofuels policy. UNCTAD has biofuels initiatives in place and supports the use of biofuels under very specific conditions. Nevertheless, the organization found that the inflexible and large mandates have been a driver of food price increases. UNCTAD articulates the risks of mandating large volumes of biofuels, stating that "If the required percentage goes beyond the production capacity of the agricultural sector, and if there is a preference for specific feedstocks, the market cannot function properly. The resulting pressure could exacerbate the market price reaction and contribute to generate expectations for even higher prices in futures

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[6] National Chicken Council report.

[7] Whitacare, Paula, ed. *Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy*. Rep. Washington, DC: National Academies, 2011.

[8] "U.S. Corn Historical Rates." *U.S. Corn Historical Rates*. FOREXPROS, 29 Aug. 2012. Web. 29 Aug. 2012. http://www.forexpros.com/commodities/us-corn-historical-data.

markets." UNCTAD goes on to say that what is needed is for "the United States and the European Union and for other countries relying on mandated blending volumes or percentages to introduce flexibility in those targets so as to restore the natural balance played by markets. When biofuels are mandated, biofuel producers can outbid other consumers of the feedstocks. Moreover, rising mandated volumes fuel investor expectations about the future of the industry, further adding pressure to prices."[9]

<u>The Drought</u>

This last summer's combined drought and heat wave was the most severe in the last 50 years and is negatively impacting yields of many crops, particularly soybean and corn, where yields have dropped by almost a third. With this reduction in supply, the input costs of the nation's food companies have risen significantly. The impact of the U.S. drought on global markets was exacerbated by other countries suffering from weather-related production issues. Almost continuous rain is caused problems for the wheat crop in many European countries, whereas the wheat crops in Russia, Ukraine and Kazakhstan had been hit hard by a lack of rain.[10]

The result is that from the end of May through August, average monthly corn prices increased by 33 percent.[11] While a portion of that increase in price was caused by the drought, the RFS and the mandate to produce renewable fuels from those commodities exacerbated the problem. With EPA choosing not to exercise its discretion to waive all or a portion of the mandate, the impact of the short crop was magnified on those that needed corn and soy as feedstocks.

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[9] "UNCTAD's Position On Biofuels Policies And The Global Food Crisis." *UNCTAD.org*. United Nations Conference on Trade and Development, n.d. Web. 20 Sept. 2012. (emphasis in the original). <http://archive.unctad.org/templates/Page.asp?intItemID=4526&lang=1>.

[10] The World Bank. *Food Price Volatility a Growing Concern, World Bank Stands Ready to Respond*. *The World Bank*. WorldBank.org, 30 July 2012. Web. 10 Sept. 2012. <http://www.worldbank.org/en/news/2012/07/30/food-price-volatility-growing-concern-world-bank-stands-ready-respond>.

[11] "U.S. Corn Historical Rates." *U.S. Corn Historical Rates*. FOREXPROS, 29 Aug. 2012. Web. 29 Aug. 2012. http://www.forexpros.com/commodities/us-corn-historical-data.

USDA cited beef prices increasing 6.4% IN 2012 AND poultry 5.5%. The increase in protein prices his would have a significant impact on the financial health of our nation's families now struggling to make ends meet.[12]

Economics

Higher food and fuel prices have serious macroeconomic effects throughout the global economy, including adverse effects on growth and inflation, and large swings in the terms of trade—with important balance of payments repercussions.[13]

In a lengthy report, the Organization for Economic Cooperation and Development noted, "the *nature and composition of demand* are factors that may increase the future variability in world prices. First, industrial demand for grains and oilseeds and in particular policy-driven demand for biofuels production is generally considered less responsive to prices than traditional food and feed demand. Second, food demand becomes less responsive to price changes as incomes rise and the commodity share in the food bill falls. Such changes are *permanent* factors that may lead to greater *volatility* in future world prices."[14]

As the National Research Council noted, "The magnitude of biofuels policy impacts depends on the economic condition in which it plays out, and that economic environment (such as growth of domestic product and oil price) is highly uncertain."[15] The drought-induced corn-shortage is another such condition. In a 2012 Iowa State study, Babcock showed "if market conditions are

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[12] *Food Price Outlook 2013*. Rep. United States Department of Agriculture Economic Research Service, March 2013. <http://www.ers.usda.gov/data-products/food-price-outlook/.

[13] Hojjat, Tahereh. "GLOBAL POVERTY AND BIOFUEL PRODUCTION: Food Vs Fuel." *International Journal of Energy Technology and Policy* (2012): n. pag. *InderScience Publishers*. Web. 20 Sept. 2012. <http://http://www.inderscience.com/info/ingeneral/forthcoming.php?jcode=ijetp>.

[14] *Rising Food Prices: Causes and Consequences*. Rep. OECD.org, 2008. Web. 21 Sept. 2012. <http://www.oecd.org/trade/agriculturaltrade/40847088.pdf>.

[15]Whitacare, Paula, ed. *Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy*. Rep. Washington, DC: National Academies, 2011. Print.

tight because of poor maize[16] yields, then the mandate will have a larger-than-average impact on market prices because it forces all the adjustment to tight supplies onto the livestock sector."[17] That is precisely the situation we have here. With USDA projecting losses of almost one-third of the corn crop, market conditions are very tight.[18]

Impact on the Poor

The economic harm to the poor of imposing 2013 ethanol obligations will be severe. According to the Bureau of Labor Statistics, households in the lowest quintile spend 34 percent of their income on food. Even with borrowing, government assistance and charity, these households spend fully 17 percent of their overall expenditures on food.[19] Thus, RFS induced increases in food prices will have a profound effect on their ability to make ends meet.

Already, a sizeable portion of the U.S. population has trouble getting enough to eat. In a comprehensive survey of more than 43,000 households by the Department of Agriculture's Economic Research Service, respondents were asked questions such as "In the last 12 months, were the children ever hungry but you just couldn't afford more food" and "In the last 12 months did you lose weight because there wasn't enough money for food." In its report released in September, USDA concluded that 17.9 million households, or 14.9 percent of the U.S. population, were food insecure in 2011.[20] This is up markedly up from 2007. While the

[16] Maize essentially refers to corn.

[17] Babcock, Bruce. *Updated Assessment Of The Drought's Impacts On Crop Prices And Biofuel Production*. Rep. The Center For Agricultural And Rural Development, Iowa State University, Aug. 2012. Web. 15 Sept. 2012. <http://www.card.iastate.edu/publications/dbs/pdffiles/12pb8.pdf>.

[18] "Statistics by Subject." *NASS.USDA.gov*. National Agricultural Statistics Service, 10 Sept. 2012. Web. 10 Sept. 2012. <http://www.nass.usda.gov/Statistics_by_Subject/index.php>.

[19] *Quintiles of Income Before Taxes: Average Annual Expenditures and Characteristics, Consumer Expenditure Survey, 2010*. Rep. United States Bureau of Labor Statistics, Sept. 2011. Web. 29 Aug. 2012. <http://www.bls.gov/cex/2010/Standard/quintile.pdf>.

[20] Coleman-Jensen, Alisha, Mark Nord, Margaret Andrews, and Steven Carlson. *Household Food Security in the United States in 2011*. Rep. United States Department of Agriculture Economic Research Service, Sept. 2012. Web. 6 Sept. 2012. <http://www.ers.usda.gov/media/884525/err141.pdf>.

primary underlying cause of for this jump was the sudden recession starting in 2008, levels have actually slightly increased, not decreased since that time. In the last year, the percentage of households that had very low food security also increased, increasing from 5.4 percent of households to 5.7 percent, or put another way, the number of households with very low food security jumped 5.6 percent in a single year, returning to the high levels of 2008 and 39 percent above 2007 levels.

While joblessness is obviously an important factor in food security, food security is also directly tied to food cost because it refers to the adequacy of the amount of food people have access to based on the relationship of how much money they have for food and how much food that money can buy. Thus, imposition of RFS obligations create an artificial demand that drives up costs and diverts corn from use as food as well as acreage devoted to other commodities, and directly contributes to food insecurity.

April 29, 2013

Honorable Fred Upton
Chairman
Honorable Henry Waxman
Ranking Member
Committee on Energy and Commerce
U.S. House of Representatives
RFS@mail.house.gov

Dear Sirs:

The Wendy's Company and Quality Supply Chain Co-op, Inc. (QSCC) appreciate this opportunity to provide comment on the questions posed concerning agricultural sector impacts in your White Paper Series on the Renewable Fuel Standard (RFS). We believe the RFS has had a severe and negative impact on food commodity prices in the U.S., and as such should be repealed or at a minimum, reformed.

The Wendy's Company operates and franchises over 5,500 quick service hamburger restaurants in the U.S.– almost 80% of which are owned and operated by hundreds of franchisees, most of whom are small business owners.

QSCC is the independent not-for-profit cooperative that oversees the food, packaging, equipment, services, and energy procurement for Wendy's company and franchised restaurants in North America. Wendy's and its franchisees constitute the membership of QSCC. It is on behalf of our members that QSCC provides comment on the agricultural sector impacts of the Renewable Fuel Standard, specifically those related to food prices.

The Committee's review of the RFS is a welcome sign that leaders in Washington are hearing the call to review this flawed policy. The harmful, far-reaching, and unintended consequences of the RFS and its free-market distortions can no longer be ignored. While the detrimental financial costs of the RFS borne by U.S. based businesses and consumers are the focus of this portion of your review, the societal concerns associated with the environment and hunger cannot be overlooked.

Simply stated, we firmly believe the RFS is creating wide-ranging social and economic harm for many while benefiting only a select few. As such, we applaud the Committee's diligent review of the RFS and thank you for the opportunity to comment.

We respectfully submit the following responses to these questions from the White Paper:

1. What has been the impact of the RFS on corn prices in recent years? What has been the impact on soybean prices? Have other agricultural commodity prices also been affected?

3. Was the EPA correct to deny the 2012 waiver request? Are there any lessons that can be drawn from the waiver denial?

5. What has been the impact, if any, of the RFS on food prices?

Response to Question 1

The impact on commodity prices has been severe. Since the implementation of Energy Policy Act of 2005 and the subsequent Energy Independence and Security Act of 2007, the annual average of the price of a bushel of corn rose from the 2005/2006 crop year to the 2011/2012 crop year by nearly 200% or nearly \$4.40/bushel[1] (this is ignoring the 2012/2013 drought crop year we are currently in, where the impact is obviously even larger). While there have been other contributing factors, including international demand and monetary easing, one cannot ignore the market distortion created by the RFS. Nearly all studies, even those done by government agencies, indicate the RFS has exerted upward pressure on the price of corn to some degree. As you stated in the white paper, "There is no question that the RFS has provided benefits for America's corn farmers by strengthening the demand for corn," a statement that firmly implies the RFS is responsible for policy-driven price inflation. We do not question that is the case, and based on both internal and credible third party studies we have undertaken and/or reviewed, including those by PwC[2] and Dr. Elam and Dr. Meyer[3], we believe the RFS impact to corn prices to be between \$1.50-\$2.25/bushel. But much more than the corn crop has been impacted.

Ignoring the ever-increasing biodiesel mandates, which have and will continue to distort the price of soybean oil, the corn ethanol mandate has as significant an impact on the price of soybeans. The U.S. agricultural system works on a system of acreage competition, wherein a finite quantity of suitable land (marginal and environmentally sensitive CRP acres aside) is distributed by market forces to various crops. Due to its place as the largest cash crop in the U.S., corn is by nature the driver of this competition. Except in certain areas, farmers often make an annual decision based on economic factors whether to plant corn or soybeans, which means that the prices of the two crops are highly correlated. Therefore, significant increases in the price of corn beget significant increases in the price of soybeans. From the 2005/2006 crop year to the 2011/2012 crop year, again ignoring the 2012/2013 drought, the average annual price of soybeans rose over \$7.80/bushel or nearly 135%[4]. Based on the same studies referenced above, we believe the impact of the corn ethanol mandate on the price of soybeans to be between \$2.10-\$5.50/bushel.

This same acreage competition and even more importantly feed substitutability factors, have led to a similarly adverse impact on domestic wheat prices (between \$0.80-\$3.40/bushel depending on type of wheat). And while they are harder to attach definitive impact figures to, the distortion to acreage competition created by the RFS corn ethanol mandate has also impacted prices for crops like potatoes, cotton, and dry beans. For example, from the 2005/2006 crop year to the 2011/2012 crop year, annual average dry bean prices in the U.S. rose over 135% or over \$25/cwt[5], an increase largely tied to acres lost to corn and soybean production. And finally, to ignore the impact to livestock, poultry, and dairy production, which not only competes head-to-head for feedstock with the government supported biofuel industry, but also has lost forage acres to row crops, would be an egregious oversight. We and our protein supply base disagree with the assertion that the impact on total animal feed supply is largely offset through the dried distillers grains (DDGs) created as a byproduct of ethanol production. These DDGs are not a one-for-one replacement for corn, can be fed minimally to non-ruminant animals like swine and poultry, and recently

[1] Chicago Board of Trade nearby contract crop year averages. Annual averages for crop years 2005/2006 to 2011/2012.
[2] PricewaterhouseCoopers. "Federal Ethanol Policies and Chain Restaurant Food Costs". October 2012.
[3] Elam, Thomas. Meyer, Steven. "Feed Grains, Ethanol, Energy Correlated". December 2010.
[4] Chicago Board of Trade nearby contract crop year averages. Annual averages for crop years 2005/2006 to 2011/2012.
[5] USDA Economic Research Service. Dry Pulse Crops. Annual average U.S. dry bean prices for crop years 2005/2006 to 2011/2012.

their nutritive value and use as a feed supplement in many operations is diminishing as a result of oil removal for RFS mandated biodiesel production. Prices of all proteins in the U.S. have risen drastically since the implementation of the RFS, well above inflation, even while margins have been consistently negative for producers and while a number of large protein companies have gone bankrupt or been opportunistically acquired by foreign entities.

Response to Question 3

We believe the EPA was incorrect to deny the 2012 corn ethanol mandate waiver requests made by the governors of ten states. The EPA ignored the economic harm caused by the combination of the RFS and the drought. It begs the question, if the worst drought in over 50 years does not satisfy the EPA's criteria for hardship, what would? And the argument that altering or suspending the corn ethanol portion of the RFS would have "no impact on ethanol production volumes" is not only false, but is counter-intuitive and damning to the very existence of the RFS in the first place. If the absence of the RFS does not change the production of biofuels, then why is there a need for an RFS?

While there are a number of lessons to be learned here about the EPA's disregard for the realities of the world or the public well-being, the more constructive lesson is one concerning the undefined and interpretable nature of the EPA's waiver powers. Since the EPA is given the power to waive for economic or environmental harm, but not provided any objective definition as to what constitutes such harm, the provision provides the public with no true protection as was demonstrated by the EPA's recent decision.

Response to Question 5

The RFS has had a substantial inflationary impact on consumer food prices. As laid out in the response to question #1, the impact to corn prices have been substantial, and as corn is either directly or indirectly related to the price of most agricultural commodities, the impact is undeniable.

Since the implementation of the original RFS, the consumer price index for food in the U.S. has risen nearly 25% (2005-2012)[6]. During the same time, core inflation in the U.S. rose just over 16%[7]. The three highest years of annualized year-over-year food inflation in the last twenty years (2007, 2008, and 2011) have all taken place since Congress passed the second phase of the RFS with the Energy Independence and Security Act of 2007[8]. Likewise, the producer price index, a gauge of the costs incurred by producers to produce food products, increased from 2005 to 2012 by almost 31%[9], indicating that not only are consumers having to pay more for food as a result of the RFS, but that those who provide that food have had to unfairly absorb some of those costs to the detriment of their business during difficult economic times.

The above impacts to consumer food prices and producer food prices by themselves might seem acceptable if, as claimed by ethanol supporters, a commensurate benefit were enjoyed in consumer fuel

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[6] Bureau of Labor Statistics. CPI, U.S. City Average, Food (CUSR0000SAF1). January 2005 to December 2012.

[7] Bureau of Labor Statistics. CPI, U.S. City Average, All Items Less Food And Energy (CUSR0000SA0L1E). January 2005 to December 2012.

[8] Bureau of Labor Statistics. CPI, U.S. City Average, Food (CUSR0000SAF1). December-to-December Annual Changes 1993 to 2012.

[9] Bureau of Labor Statistics. PPI, Stage of Processing, Finished Consumer Foods (WPSSOP3110). January 2005 to December 2012.

prices. If consumer fuel prices had deflated, or at least tracked relatively in line with core inflation, then the consumer cost shift to food might be acceptable. However, during the same time period described above, the consumer price index for gasoline in the U.S. rose a staggering 84%[10].

Consumer price data seems to indicate that not only is the RFS responsible for unnecessary inflation in consumer food prices, but that the consumer receives no commensurate benefit from the policy in the form of lower prices at the pump.

These, along with the many other damaging and unintended consequences associated with the RFS, point to a policy not only flawed, but to one that emphasizes the benefit of one subsection of the American economy to the detriment of the overwhelming majority of businesses and consumers.

We thank you for the opportunity to comment.

Best Regards,

The Wendy's Company
Quality Supply Chain Co-op, Inc.
One Dave Thomas Boulevard
Dublin, OH 43017
(614) 764-3100

[10] Bureau of Labor Statistics. CPI, U.S. City Average, Gasoline All Types (CUSR0000SETB01). January 2005 to December 2012.

Tyson Foods, Inc.

April 29, 2013

The Honorable Fred Upton
Chairman, House Committee on
Energy & Commerce
2125 Rayburn House Office Building
Washington, DC 20515

The Honorable Henry Waxman
Ranking Member,
House Committee on
Energy & Commerce
2125 Rayburn House Office Building
Washington, DC 20515

Dear Chairman Upton and Ranking Member Waxman:

On behalf of Tyson Foods, Inc. and the nearly 100,000 Team Members that work at our locations in 24 states, I am writing to commend the Committee's ongoing assessment of the Renewable Fuels Standard (RFS). The RFS program, and particularly its expansion as a result of the Energy Independence and Security of 2007 (EISA), has had very significant impacts on certain sectors of the U.S. economy and we agree that a review at this time is appropriate.

We appreciate that the Committee's second White Paper has chosen to focus on agricultural sector impacts and are pleased to offer our thoughts on some of the stakeholder questions. Tyson is one of the world's leading producers of meat and poultry products and one of the world's largest purchasers of grains. Millions of American's depend upon Tyson to provide safe, nutritious and affordable food to feed their families. Given our position in the food production system, there are few, if any, companies that better understand the relationship between the price of U.S. corn products and the prices American consumers have to pay to provide their families with the meat and poultry that should be part of any balanced diet.

As a general matter, at Tyson we believe that the RFS was well-intentioned policy and that most lawmakers were seeking to address important issues such as energy security, sustainability and environmental improvement. In addition, our company is directly involved in the biofuels industry as a joint partner in Dynamic Fuels LLC, which operates a renewable diesel facility in Geismar, Louisiana. We think that next generation facilities like Dynamic Fuels, which produce high performing, drop-in biofuels from non-feed based feedstocks hold real promise.

However, during the debate over EISA in 2007, Tyson and others in our industry expressed deep concerns with the proposed mandate increases for corn-based ethanol. We argued at the time that the proposed targets for conventional ethanol were too high and that they would divert a significant amount of corn to biofuel production, leading to higher prices for food and feed. As the Committee's White Paper indicates, the diversion of food crops for biofuel production was part of the debate in 2007, but in our view it received too little attention and analysis. During the EISA debate we also pushed for stronger waiver provisions to deal with potential corn shortages and prices spikes, but unfortunately these proposals were not adopted.

As the Committee carries out its assessment and looks forward to consideration of potential changes to the RFS, we think that some review of the 2007 debate is instructive. Over nearly six and a half years, our industry has been very consistent about its concerns with the corn ethanol mandate and, in fact, many of the negative impacts we predicted back in 2007 have been borne out. These impacts are reflected in the questions posed in the Committee's White Paper and below are our comments on those most relevant to our company.

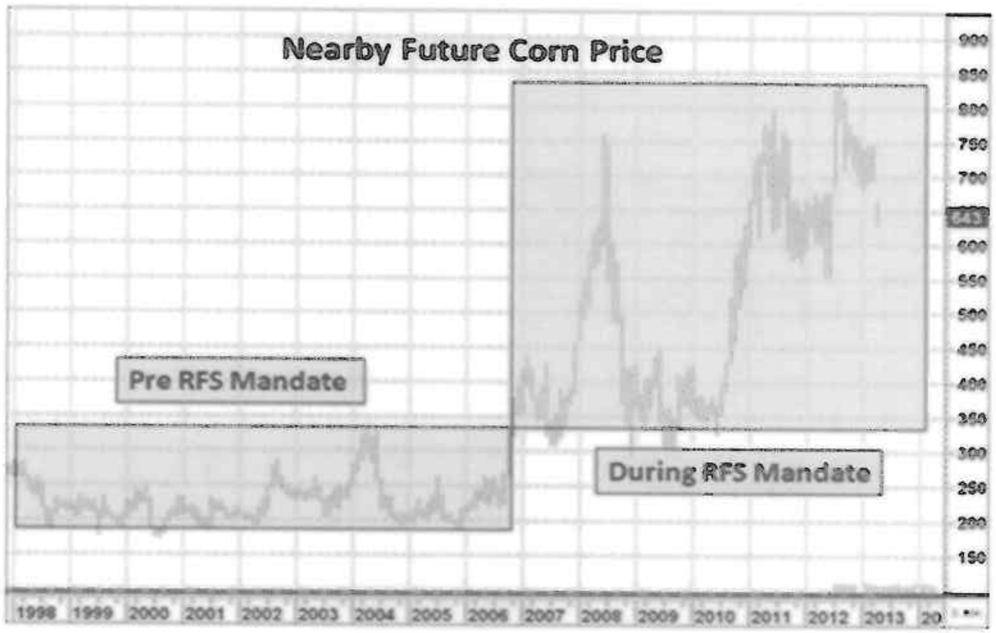
Again, thank you for the opportunity to provide input on these important issues. Please let me know if additional information from Tyson Foods would be helpful to your work.

Sincerely,

Clark Irwin
Senior Vice President,
Commodity Purchasing

1. **What has been the impact of the RFS on corn prices in recent years? What has been the impact on soybean prices? Have other agricultural commodity prices also been affected?**

   In our view, the RFS has had a profound impact on the price of corn, soybeans and other grains that are important to animal agriculture. As the chart below clearly indicates, the period since passage of EISA has been one of significantly higher corn prices, tighter corn stocks and greater volatility. Since corn is the most important ingredient in animal feed, its price directly influences the price of soybeans and other grains.



The fundamentals are fairly basic, the corn market functions best when there is a sufficient amount of carry-over, ideally somewhere at or above 10 percent. However, as a greater percentage of corn is diverted to ethanol production each year, the margin for error in the market narrows. Based on current USDA data, 42 percent of this year's corn crop will be used for ethanol production. Although some percentage of that amount is returned to the market in the form of dried distiller's grains (DDGs), their effectiveness as a substitute for corn varies by animal species and there is also a great amount of variation in both the quality and retained energy of DDGs. Also, as clearly illustrated above, DDGs have done little to prevent corn prices from reaching historically high levels since passage of EISA.

Essentially, we need record corn crops every year to keep ahead of demand, and maintain carry-over at healthy levels, but yield gains and acreage are not keeping up with demand - even though we had a record amount of 96 million acres planted in 2012. Absent sufficient carry-over, we not only see higher prices but greater volatility. The chart below illustrates the real-world impact from periods when the stocks-to-use ratio dips below 10 percent - periods that are occurring with much greater frequency since passage of EISA.

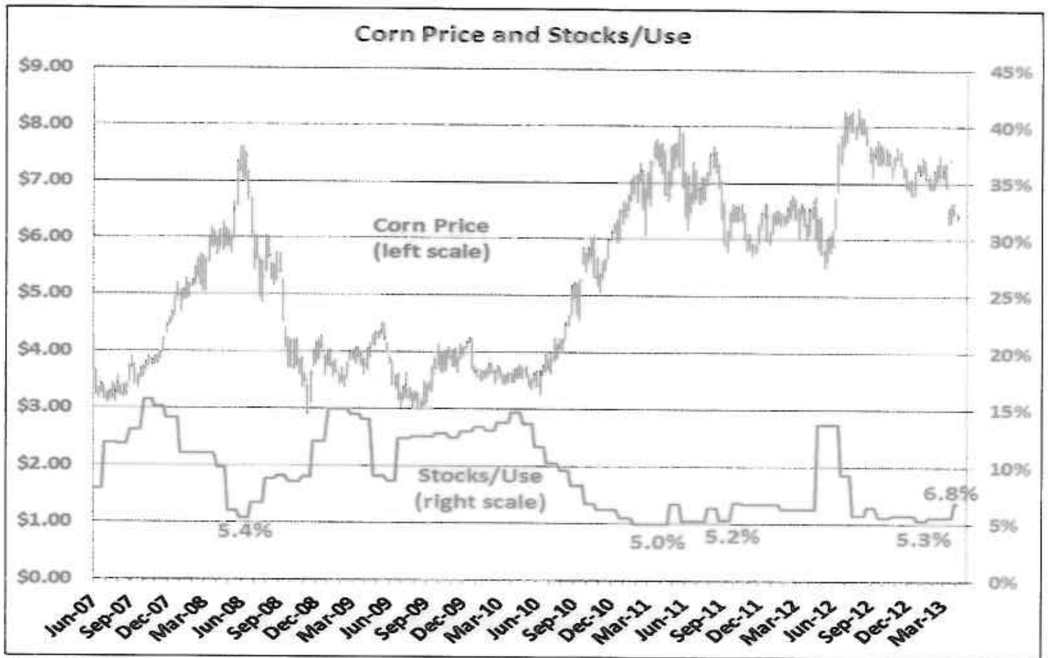


Chart Source: Data from DTN ProphetX

With regard to other grains, we have seen increases of $100 to $225 per ton for soybean meal since imposition of EISA. According to a recent study by economist Dr. Tom Elam the price for soybean meal has increased by 120 percent since 2005. In that same study, he found that the cumulative cost increase for corn, soybean meal and wheat from 2005-2012 was $229.2 billion dollars. Clearly, the dominant factor in these increases has been the federal mandates for biofuels, particularly corn ethanol.

2. How much has the RFS increased agricultural output? How many jobs has it created? Have any jobs been lost? What is the net impact on the agriculture sector?

We believe that other stakeholders are better positioned to address most of these questions, but there is no question the RFS has led to the loss of jobs in our industry. According to industry estimates, between 2008 and 2011, approximately 28 percent of the U.S. broiler industry experienced bankruptcy, sale or closure. We have also seen marked contraction in the beef sector as well. Although the six-year decline of the country's beef cattle herd is certainly related to the persistent drought in key cattle areas, higher and more volatile feed prices have also been a contributing factor. These disruptions have meant lost processing and producer jobs as well as missed opportunities for expansion and the creation of new jobs.

3. **Was EPA correct to deny the 2012 waiver request? Are there any lessons that can be drawn from the waiver denial?**

Tyson Foods was a strong supporter of the waiver petitions submitted to the Environmental Protection Agency by the governors of ten states. Last year's drought was historic in nature and severe in its impacts. Food processing jobs were lost and more livestock producers were forced off the farm. The spike in corn and soybean meal prices from last summer is still being felt by our industry through hundreds of millions of dollars in increased input costs. These increases will ultimately impact American consumers who will have to pay higher prices for protein and other food staples. In our view, the mandate should have been sharply reduced or suspended to allow market forces to allocate the limited corn supply. As Tyson expressed in its letter to the EPA Administrator last year, a waiver could have accomplished three key outcomes: 1) level the playing field for all stakeholders who depend on corn for their businesses; 2) replenish the U.S. and world corn stocks; and 3) mitigate the impact to U.S. and global consumers.

The 2012 waiver request process clearly demonstrates that there is currently no viable avenue for relief for industries, states, regions or consumers impacted by the RFS. A bipartisan group of governors and a significant percentage of the United States Congress asked the Environmental Protection to waive the biofuels mandates in the face of the worst drought in half a century. These petitions fell on deaf ears and the EPA made it clear in its response that the conditions necessary for granting a waiver are almost unachievable. There is a fundamental problem with a waiver process that protects the ethanol industry at the expense of other stakeholders.

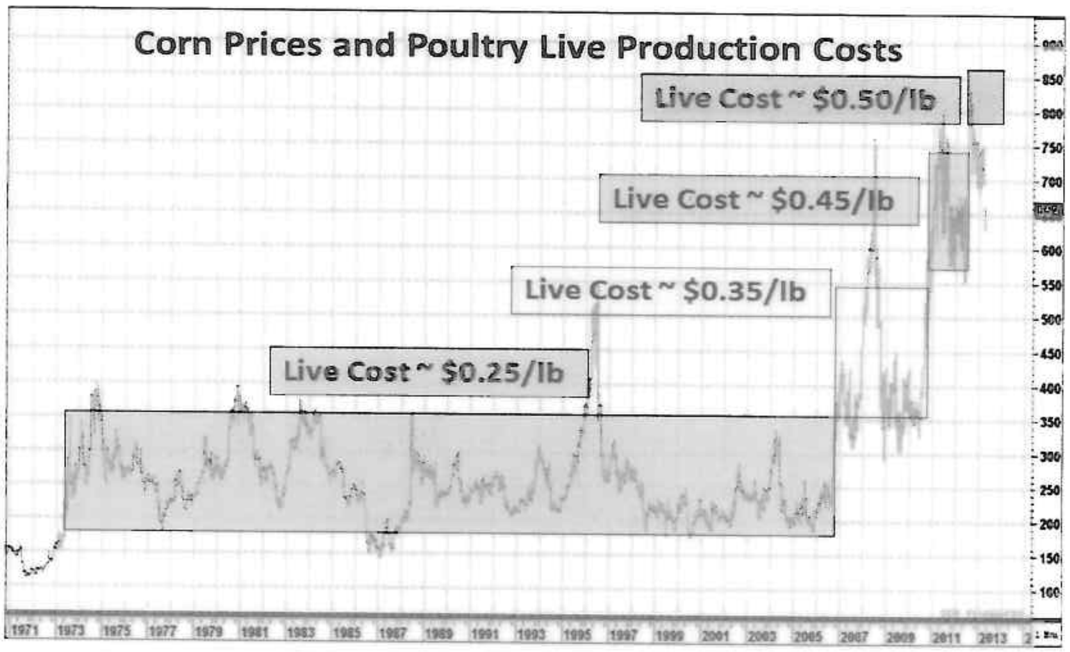
4. **Does the Clean Air Act provide sufficient flexibility to adequately address any effects that the RFS may have on corn price spikes?**

As explained above, we do not believe that current law provides for a workable mechanism to respond to corn prices spikes and supply shortages. While we would contend that the Committee should look at the overall costs and benefits associated with even maintaining a mandate on corn ethanol, at the very least there should be waiver provisions in place that are transparent, timely and fair to all stakeholders. As previously discussed, there is a clear correlation between the carry-over level, or stocks-to-use ratio, and the price of corn. A properly designed waiver provision would be triggered by key data points like the stocks-to-use ratio.

5. **What has been the impact, if any, of the RFS on food prices?**

Because it has raised the price of key inputs for food products, the RFS has contributed to increased food prices generally and significantly higher meat and poultry prices in particular. Dr. Elam's recent analysis confirmed that food inflation, particularly for those food categories most impacted by grain costs, has risen much faster than overall inflation since 2005. The steady trend of improving food affordability for Americans has reversed and now food is becoming less affordable. This is neither good for our economy nor our overall standard of living.

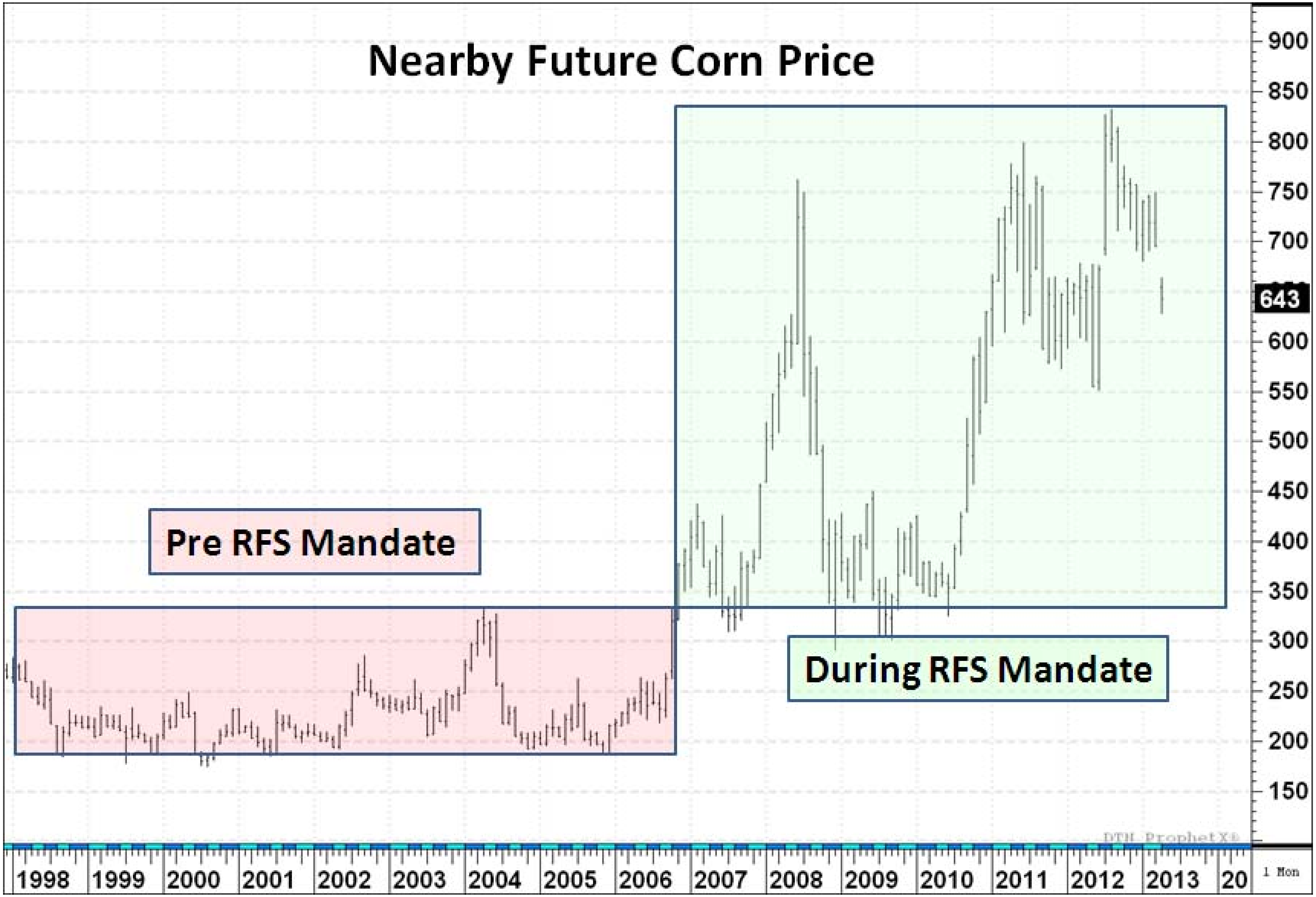
The consumer costs for meat and poultry, which are heavily dependent on the price of corn and other grains, have increased faster than other food categories. Taking poultry as one example, the chart below clearly shows the correlation between corn prices and our live production costs. In short, since the corn ethanol mandate has been in place, our live production costs have doubled. Part of these additional costs must be passed along to our customers and consumers if we are to remain economically viable.



According to a study by Dr. Elam, in large part due to smaller corn supplies from 2007 to 2013, the average consumer will see a 29 percent overall meat and poultry price increase and experience an 11 percent reduction in consumption. In fact, per-capita consumption of meat and poultry has declined to the lowest level since 1990. This contraction in the $228 billion dollar meat and poultry industry, along with higher food costs for U.S. consumers, has occurred while more and more corn has been used to *increase* the production of corn ethanol. These statistics starkly illustrate who has borne the costs of federal biofuels mandates.

6. What role could cellulosic biofuels play in mitigating the potential effects of the RFS on corn prices?

If renewable fuels are to be viable in the long run, eventually without any government mandates, we should promote multiple pathways, especially for drop-in biofuels that are compatible with the nation's existing fuel infrastructure. An important aspect of this is providing feedstock flexibility in the production of biofuels. The EPA currently has 26 pending pathways awaiting determination, with some petitions pending for two years. A more timely response or approval of these items provides additional flexibility for raw materials in biofuels production and gives advanced biofuels producers the chance to operate competitively, with the ultimate goal of competing in an open marketplace.



Nearby Future Corn Price
Pre RFS Mandate
During RFS Mandate
900
850
800
750
700
643
600
550
500
450
400
350
300
250
200
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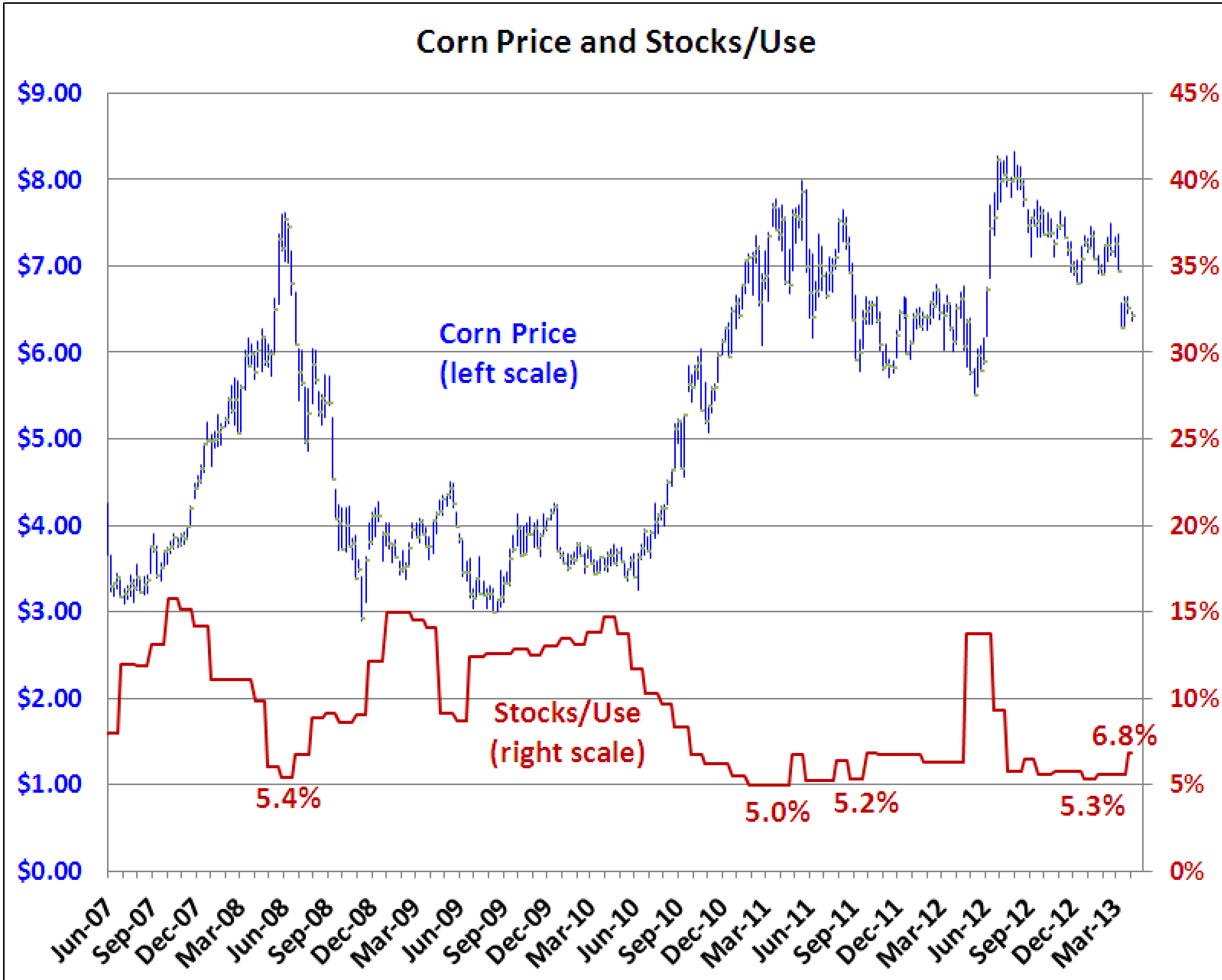
20
1 Mon



Corn Price and Stocks/Use
$9.00
$8.00
$7.00
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Corn Price
(left scale)
Stocks/Use
(right scale)
5.4%
5.0%
5.2%
5.3%
6.8%
Jun-07
Sep-07
Dec-07
Mar-08
Jun-08
Sep-08
Dec-08
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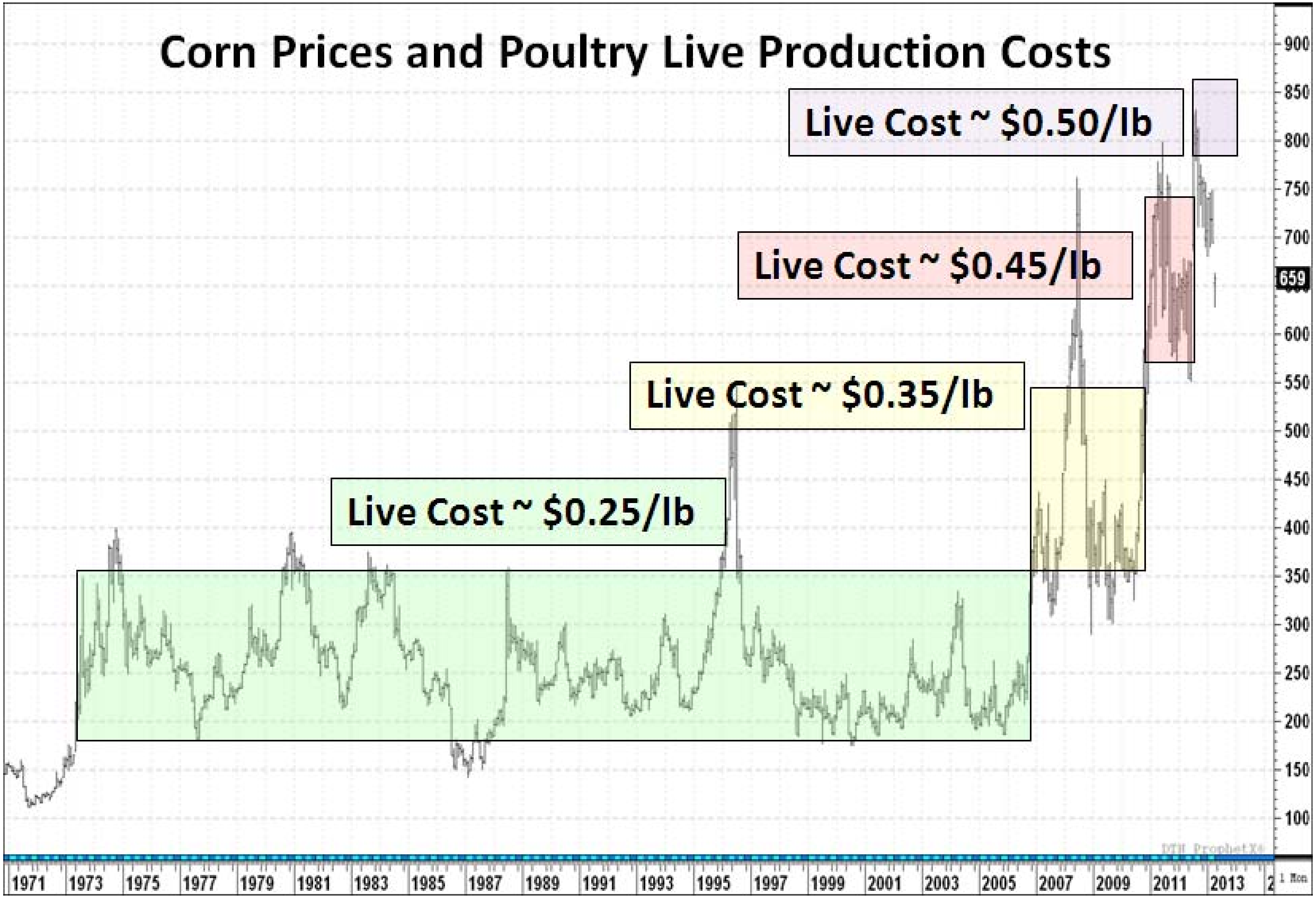
Mar-13



Corn Prices and Poultry Live Production Costs
Live Cost ~ $0.50/lb
Live Cost ~ $0.45/lb
Live Cost ~ $0.35/lb
Live Cost ~ $0.25/lb
900
850
800
750
700
659
600
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Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

April 29, 2013

The Honorable Fred Upton
Chairman
Committee on Energy and Commerce
United States House of Representatives
2125 Rayburn House Office Building
Washington, DC 20515

The Honorable Henry Waxman
Ranking Member
Committee on Energy and Commerce
United States House of Representatives
2322A Rayburn House Office Building
Washington, DC 20515

Dear Chairman Upton and Ranking Member Waxman:

Thank you for the opportunity to share our views on the future of the Renewable Fuels Standard (RFS) as part of your white paper series. The Union of Concerned Scientists (UCS), the nation's leading science-based nonprofit putting rigorous, independent science to work to solve our planet's most pressing problems, is working to cut our nations oil consumption in half over the next 20 years[1], and better biofuels are an important part of that plan.
UCS has recently completed relevant analysis on many of the questions raised in the April 18th white paper on "Agricultural Sector Impacts." The full analysis can be found in comments submitted to the US Environmental Protection Agency's (EPA's) "Request for Comment on Letters Seeking a Waiver of the Renewable Fuel Standard" 77 Fed. Reg. 52715 (August 30, 2012) [EPA-HQOAR-2012-0632; FRL-9721-7] (the "2012 waiver request"),[2]" and the U.S. EPA's "Regulation of Fuels and Fuel Additives: 2013 Renewable Fuel Standards" 78 Fed. Reg. 9282 (February 21, 2013) [EPA-HQ-OAR-2012-0546] (the "2013 volume rulemaking")[3] and a short report we published in 2012 on "The Promise of Biomass.[4]"

1. ***What has been the impact of the RFS on corn prices in recent years? What has been the impact on soybean prices? Have other agricultural commodity prices also been affected?***

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[1] See the UCS Half the Oil plan, at halftheoil.org.
[2] Union of Concerned Scientists. Letter to the Environmental Protection Agency. October 11, 2012, on Docket ID No. EPA–HQ–OAR–2012–0632. http://www.regulations.gov#!documentDetail;D=EPA-HQ-OAR-2012-0632-2253
[3] Union of Concerned Scientists. Letter to the Environmental Protection Agency. April 5, 2013 on Docket ID No.
EPA-HQ-OAR-2012-0546. http://www.ucsusa.org/assets/documents/clean_vehicles/UCS-Comments-on-RFS-2013-Volumes.pdf
[4] Union of Concerned Scientists (UCS). 2012b. Biomass Resource Assessment. Online at http://www.ucsusa.org/assets/documents/clean_vehicles/Biomass-Resource-Assessment.pdf

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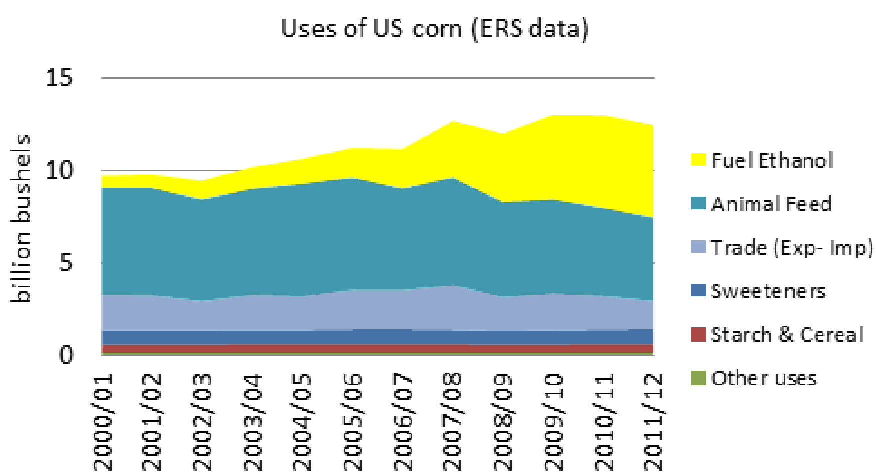
It is clear from analysis by all the major agricultural economic models that increased use of corn grain for ethanol, and to a lesser extent soybean oil for biodiesel, has played a significant role in higher corn prices, soybean prices and agricultural land prices, as well as the prices for milk, meat and other agricultural products that rely on corn and soybeans as inputs. The role of the RFS versus the Volumetric Ethanol Excise Tax Credit, the prohibition of MTBE use or other contributing factors is complex to separate, but the RFS was clearly a significant contributing factor. However, while it is clear these policies played a significant role in driving the rapid expansion of the corn ethanol industry, it is also clear that removing these policies would not reverse the gains made by ethanol in gasoline markets, and most analysis suggests that even in the absence of policy support, ethanol would likely continue to be blended with gasoline at approximately 10% because the underlying economics support it. More details are available in our comments on the 2012 waiver request

2. ***How much has the RFS increased agricultural output? How many jobs has it created? Have any jobs been lost? What is the net impact on the agriculture sector?***



Data source: USDA ERS[5]

A review of the basic agricultural statistics makes it is clear that farmers have increased production of corn to meet increased demand for ethanol. We do not have specific information on the precise numbers of jobs gained and lost.

3. ***Was EPA correct to deny the 2012 waiver request? Are there any lessons that can be drawn from the waiver denial?***

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[5] United States Department of Agriculture (USDA). 2013. Feed Grains: Yearbook tables. Online at http://www.ers.usda.gov/data-products/feed-grains-database/feed-grains-yearbook-tables.aspx#.UVMQrBek9mh.

In our comments to EPA on the 2012 waiver request we argued that a modest adjustment in the 2013 ethanol mandate, of approximately 15%, would have maintained stability in biofuels markets while allowing flexibility for markets to adjust to the dramatically reduced corn availability. In our view, a severe drought is precisely the sort of event that merits the use of the waiver provision, and we disagree with the EPA's decision to deny the waiver.

4. Does the Clean Air Act provide EPA sufficient flexibility to adequately address any effects that the RFS may have on corn price spikes?

The RFS has several design features which provide flexibility, including the ability to trade RINs and to carry forward a certain portion of excess RINs. These features mitigated to some degree the extent of the impact of the RFS on corn prices, but because of the pricing of ethanol and other gasoline blending components, the impact of this flexibility was limited. More details on this point are in the comments UCS submitted on the 2012 waiver request. Going forward, we believe the EPA should administer the RFS with a greater degree of flexibility than it has to date. This becomes increasingly important as the share of the corn market consumed by ethanol increases. More details on this point are discussed in the comments UCS submitted on the 2013 volume rulemaking.

5. What has been the impact, if any, of the RFS on food prices?

The RFS has clearly had an impact on the prices of corn and competing crops, which pass though into prices especially for meat and milk, which we discussed in a couple recent blogs[6]. Other experts have more details on the precise contribution than we do. Looking forward, the price impact of the RFS will also be influenced by decisions about whether and how much to adjust the advanced and conventional biofuel volume mandates in line with adjustments to cellulosic biofuel mandate. We have discussed the potential impact on corn and sugar prices in our comments on the 2013 volume rulemaking, and the impact on prices of other crops and foodstuffs is discussed in the 2013 OECD/FAO Agricultural Outlook[7], and Meyer and Thompson[8].

6. What role could cellulosic biofuels play in mitigating the potential effects of the RFS on corn prices?

[6] See for example, http://blog.ucsusa.org/the-food-versus-fuel-fight-is-about-much-more-than-corn and http://blog.ucsusa.org/the-coming-fork-in-the-road-for-biofuels

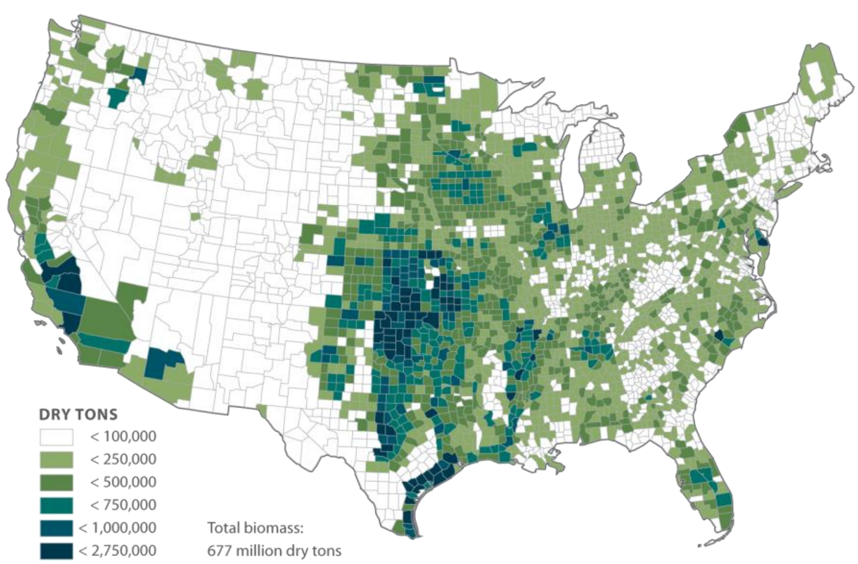
[7] Organization for Economic Co-operation and Development (OECD) and Food and Agriculture Organization of the United Nations (FAO) Agricultural Outlook 2012-2021. 2012a. Increased productivity and a more sustainable food system will improve global food security. Online at http://www.oecd.org/site/oecd-faoagriculturaloutlook/.

[8] Meyer, S., Thompson, W. How Do Biofuel Use Mandates Cause Uncertainty? United States Environmental Protection Agency Cellulosic Waiver Options. 2012a. Vol. 34. Applied Economic Perspectives and Policy. Online at http://aepp.oxfordjournals.org/content/34/4/570.abstract?sid=a6080642-551d-447d-909d-4a6f868094c4.

Cellulosic biofuels are produced from parts of plants that are not digestible by humans, so by definition they are not made from human food. Some feedstocks for cellulosic biofuels, such wastes from agriculture or garbage will have no impact on food prices whatsoever. Other potential feedstocks, like perennial grasses, would compete with other crops for land and could be produced from forage crops, so there is a potential for limited competition with food. However, detailed economic analysis of this potential competition suggests that the extent of this competition would be quite limited. For example, the Department of Energy's Billion Ton Update[9] found that even under conditions that see energy crop production on several hundred million acres, corn prices would increase just a 4%, or $0.14 a bushel. It is worth pointing out that this price impact would only be realized when cellulosic biofuels or other uses of biomass grew to a scale of several times the full 16 billion cellulosic target of the RFS. Under present market conditions our analysis suggests it will be at least two decades before cellulosic biofuels are able to scale up to this extent. There are also numerous other ways to integrate production of perennial crops with crops like corn, for example introducing perennial strips to reduce soil loss, which can over this timeframe allow perennials energy crops to expand production while continuing high levels of production of corn or other crops.

7. *What impact are cellulosic biofuels expected to have on rural economies as the production of such fuels ramps up?*

Cellulosic biofuels can be produced from a wide variety of materials available all over the country, as shown in the map below.



[9] U.S. Department of Energy (DOE). 2011. U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry. R.D. Perlack and B.J. Stokes (Leads), ORNL/TM-2011/224. Oak Ridge National Laboratory, Oak Ridge, TN. 227p.

Biomass resources totaling just under 680 million dry tons could be made available, in a sustainable manner, each year within the United States by 2030. This is enough biomass to produce more than 54 billion gallons of ethanol (four times as much corn ethanol as the United States produced in 2010). These biomass resources are distributed widely across the United States, ensuring that communities across America can benefit both financially and environmentally from increased biomass production. For more information on these resources, please see our biomass report.

8. *Will the cellulosic biofuels provisions succeed in diversifying the RFS?*

The cellulosic biofuels provisions are well designed to diversify the RFS, but it will take longer than 2022 to reach the level of cellulosic biofuel envisioned in the RFS. Additional policy support in the tax code or farm bill can speed the development of cellulosic biofuels, but substantial changes to the RFS will set back development of the cellulosic industry, as investors wait for new rules to be finalized before making continued investment. It is important for EPA to recognize that more time is required to reach the level of cellulosic production envisioned in the RFS, and adjust all the mandates in concert with the required adjustments in the cellulosic mandate as described in our comments on the 2013 Standard.

9. *What is the scale of the impact of the RFS on international agricultural production and global land use changes?*

The RFS, together with the other policies previously mentioned, has already had a profound impact on global agricultural markets, and failure to administer the RFS in a prudent manner going forward will cause additional problems. Fortunately EPA has the flexibility they need to reduce the impact going forward, as we describe in detail in our comments on the 2013 volume rulemaking.

Again, thank you for the opportunity to share our analysis on the RFS. On behalf of UCS's more than 400,000 supporters, and network of more than 23,000 scientists, engineers and public health professionals, we urge you to maintain and support policies that support cellulosic biofuels and other oil saving solutions.

Regards,

Jeremy I. Martin, Ph.D.
Senior Scientist
Clean Vehicles Program
Union of Concerned Scientists
1825 K Street NW, Suite 800,
Washington DC 20006-1232
(202) 331-6946

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Organizations: University of Illinois, Department of Natural Resources and Environmental Sciences; Energy Biosciences Institute
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1. Although I am not an economist specializing in the question put forth, Congress should be very careful in the use of modeled results to analyze the effect of biofuels incentives on food prices. While most academics agree that there was some effect, studies vary dramatically in final numbers attaching a causal relationship. Congress should not rely on any modeled result without expert, unbiased opinion on the assumptions models make and the data they rely upon. I recently published a law review article (1) highlighting the need for policymakers/lawyers to be more involved in the modeling process ex ante and ex post in order to sort pretext from fact, and to take into account uncertainty inherent in modeled results. The question involves highly complex, international market relationships that by their very nature require economists to make simplifying assumptions. The food versus fuel debate has also completely neglected the developed world's inefficient food distribution and consumption patterns. Kim et al. (2) highlight the shortfalls in allocations lifecycle analysts have made with regard to indirect land use change. The same shortfalls plague modeling of biofuels' effects on food prices; for example, the food prices consequences of biofuels must take into account diversion of primary food sources (e.g., corn and soy) to meat production. Any conversation that does not include a systems view of land use, therefore, is neither informed nor legitimate.

2. This question should be rephrased to consider economic development *beyond merely direct job creation* (3). The RFS has been a great driver of building green innovation and infrastructure within agricultural landscapes that both creates jobs and fortifies existing economic activity with more forward-thinking environmental and social knowledge (4). This analysis of "greenness," as opposed to only generic economic development, is critical because "greenness" distinguishes and justifies bioenergy sector incentives in an extreme climate of budget austerity and political polarity. Admittedly, academia has failed to adequately develop a framework for evaluating what constitutes a "green" economy, including by what metrics it should be measured. The Energy Biosciences Institute has case study research efforts underway, albeit in their early stages. These efforts have sprung forth largely in response to looming bioenergy compliance requirements that for the first time seek to measure the economic and social benefits of environmental improvements within the broader meaning of "bio" fuels. Regulators at home and abroad are keen to explore environmental and social impact metrics that tie to achievements for project funding decisions, thus driving demand by the private sector for standards that define their contributions to a "green" economy. Those standards are currently under development in many arenas. It would be premature to amend or abolish the RFS without taking into consideration how it has been responsible for driving a new sustainability paradigm within rural landscapes that includes development of "green" rural economies.

4. Section 203 and 204 establish ample scientific processes that would generate credible information for EPA to base a decision about food price effects; the problem is that agencies have not received enough funding to complete these studies. More money is necessary to land grant institutions to

study the food/fuel/land resource dynamic more holistically; while USDA has funded AFRI-CAP projects to commercialize biofuels, it and other agencies should fund an institute(s) to address broader resource competition questions from a systems perspective. Only this perspective can inform comprehensive legislation that avoids the problems the RFS is currently caught up in.

7. Because no commercial scale cellulosic biofuels facilities have been established in the U.S. yet, it is difficult to answer this question empirically, although we can look to Brazilian success with sugarcane ethanol as an indicator of what a biobased-economy can achieve for rural economic development (see also answer to question 2 above). To the extent it may be argued, however, that Brazilian ethanol should fulfill U.S. demand because it is most efficient, Brazilian scholars have documented instances where economic benefits have not been distributed evenly to workers in the sector. That said, from a U.S. perspective, where labor laws are more consistently applied, the environmental and socio-economic benefits of cellulosic fuels should be expected to be even greater than that of the corn ethanol industry. Many academic studies, too long to list, have documented the environmental and economic benefits of a future cellulosic industry.

8. The answer to this question relates to my point in the answer to question 1 above—any answer to this question would derive from modeled results, which should be viewed skeptically. Even if an answer were available, policymakers must also look at other drivers of land use changes as part of the RFS discussions, not only biofuels in isolation. I find it astounding and absurd that biofuels must shoulder almost the entire burden of calculating indirect land uses changes resulting from international, market-mediated commodity signals; in no other statute is this type of calculation required. Land use changes can easily be addressed through direct governance improvements. For example, many blame conversation of grasslands on biofuels; if such conversion is occurring, then why not prevent the conversion directly through a sod-buster amendment? The land use change conversation, driven by shortsighted and pretextually motivated individuals in academia and the private sector, neglects the positive economic, environmental and social effects of biofuels production. For example—and this is only one example among many—we are now having conversations about the importance of multi-functional landscapes in agriculture primarily because of research on the benefits of perennial cropping associated with biofuels production. This and the multitude of other land use benefits are NEVER mentioned in the RFS debate.

1. Endres, J. (2013). The Legal Profession's Critical Role in Systems-Level Bioenergy Decision-Making. 30 *Pace Envtl. L. Rev.* 652-694.
2. Kim, S. et al. (2012). An alternative approach to indirect land use change: Allocating greenhouse gas effects among different uses of land. *Biomass & Bioenergy* 46: 447-452.
3. Peters, D. et al. (2010). An Exploration of Green Job Policies, Theoretical Underpinnings, Measurement Approaches, and Job Growth Expectations (Iowa State).
4. Endres, J. (2013). Legitimacy, Innovation, and Harmonization: Precursors to Operationalizing Biofuels Sustainability Standards, 37 *S. Ill. U. L. Rev.* 1-52.

April 29, 2013

The Honorable Fred Upton
Chairman
Energy and Commerce Committee
U.S. House of Representatives
2125 Rayburn House Office Building
Washington, DC 20515

The Honorable Henry A. Waxman
Ranking Member
Energy and Commerce Committee
U.S. House of Representatives
2322A Rayburn House Office Building
Washington, DC 20515

Dear Chairman Upton and Ranking Member Waxman:

Virent is pleased to comment on the U.S. House of Representatives Committee on Energy and Commerce second white paper reviewing the Renewable Fuel Standard (RFS2).

Virent is a Madison, Wisconsin based company that uses patented catalytic technology to convert plant-based materials into a range of products identical to those made from petroleum, including gasoline, diesel, jet fuel, and chemicals used to produce plastics and fibers. Please visit www.virent.com for more information.

As the committee is aware, the Renewable Fuel Standard was expanded as part of the Energy Independence and Security Act of 2007, which created specific requirements for advanced biofuels, including the biomass-based diesel, advanced, and cellulosic biofuels pools. The clear vision of Congress in drafting this statute was to encourage the production of an entirely new range of fuels from a broad and diverse array of feedstocks. We agree that many factors such as potential impacts to the agricultural sector and the potential of second generation biofuels to meet these challenges makes this an appropriate time to assess the course and implementation of the RFS2 program. We applaud the committee's efforts in this regard.

Based on Virent technology and positioning within the biofuels and biobased chemicals industry, we feel it is appropriate for us to comment on five (Questions 5 through 9) of the nine questions posed by the white paper. We would also suggest that the committee consider commissioning studies that examine Questions 1 and 2. There will likely be wide variance in the responses, and a detailed analysis of the data would be useful to better inform decision makers.

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Question 5: What has been the impact, if any, of the RFS on food prices?

Most experts agree that rising food prices have been caused by a plethora of factors from the increased demand for feed uses and the drought, to rising crude oil prices and volatility in the strength of the US dollar. The use of grain for biofuels is only one small input among many that have affected food prices. For example, as Figure 1 below indicates[1], the fact that more meals are consumed outside the home (convenience costs) has had the largest impact on US food prices since 2000, while the farm share of the US food dollar has steadily declined. Notably during this period, the price of petroleum derived fuel for the agricultural producer has risen.

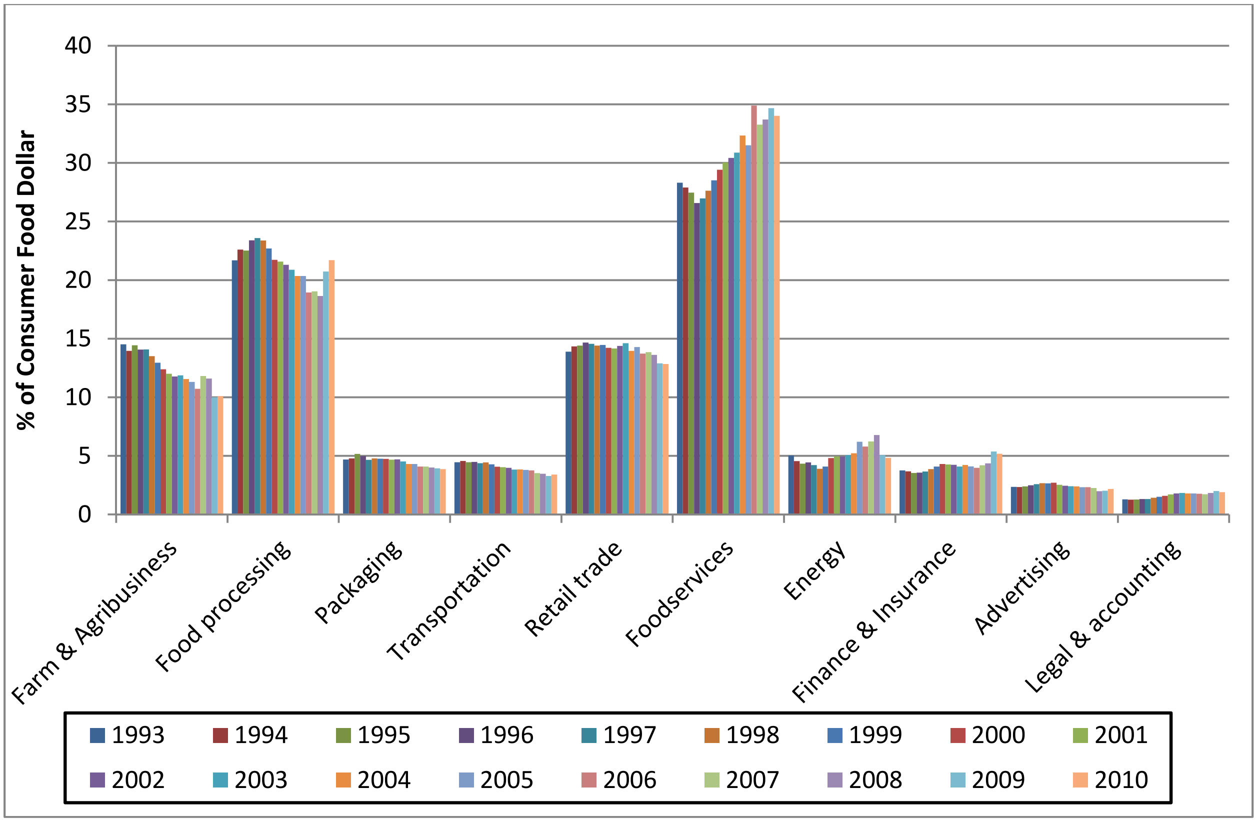

Figure 1

Question 6: What role could cellulosic biofuels play in mitigating the potential effects of the RFS on corn prices?

Just as the production of biofuels has the potential to increase supply and diversify the feedstock base of liquid fuels, cellulosic biofuels have the potential to impact the inputs and costs of biofuel production itself. As alternative feedstocks come on line and US demand for ethanol remains relatively constant or possibly even contracts (due to the blend wall constraints

[1] USDA Food Dollar Series, http://www.ers.usda.gov/data-products/food-dollar-series/food-dollar-application.aspx#.UX6GQsrBe-U

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on the market), then the production of ethanol from cellulose will free up corn for more desirable markets such as feed, and new uses such as the production of higher value drop-in fuels and chemicals. Moreover, the direct production of drop-in fuels and chemicals from cellulosic feedstocks has the potential to mitigate cost and volatility in both the crude oil and corn markets. This was precisely the vision of Congress in enacting RFS2 and the Committee should explore ways in which to strengthen these provisions in the RFS in order to further promote investment in cellulosic biofuel and biochemical production (see question 8 below).

Question 7: What impact are cellulosic biofuels expected to have on rural economies as the production of such fuels ramps up?

Cellulosic biofuels have the potential to provide significant positive economic impacts on rural communities as their production increases. First, cellulosic feedstock production will expand markets for existing agricultural products such as corn stover, timber and other forest and farm residues. Additionally, new markets for novel feedstocks such as high biomass sorghum, giant Miscanthus and switchgrass will be created. Finally, logistics considerations will necessitate the location of biofuel production in close proximity to the feedstock source, creating significant investment of capital in these rural communities and generation numerous high paying technical jobs for these locales. A study of the potential impacts of advanced biofuel production through 2030 by the Bio Economic Research Associates yielded the following findings:

- *Direct job creation from advanced biofuels production could reach 29,000 by 2012, rising to 94,000 by 2016 and 190,000 by 2022. Total job creation, accounting for economic multiplier effects, could reach 123,000 in 2012, 383,000 in 2016, and 807,000 by 2022.*

- *Investments in advanced biofuels processing plants alone would reach $3.2 billion in 2012, rising to $8.5 billion in 2016, and $12.2 billion by 2022. Cumulative investment in new processing facilities between 2009 and 2022 would total more than $95 billion.*

- *Direct economic output from the advanced biofuels industry, including capital investment, research and development, technology royalties, processing operations, feedstock production and biofuels distribution, is estimated to rise to $5.5 billion in 2012, reaching $17.4 billion in 2016, and $37 billion by 2022.*

- *Taking into consideration the indirect and induced economic effects resulting from direct expenditures in advanced biofuels production, the total economic output effect*

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for the U.S. economy is estimated to be $20.2 billion in 2012, $64.2 billion in 2016, and $148.7 billion in 2022.[2]

Question 8: Will the cellulosic biofuels provisions succeed in diversifying the RFS?

As implemented, we do not believe the RFS2's advanced and cellulosic provisions will be effective in diversifying the suite of biofuels produced, and thereby also fail in diversifying the US liquid fuels marketplace. The current RFS favors certain technologies, certain feedstocks, and fails to reward performance or infrastructure compatibility.

In the current RFS, the only "hard" mandates are those for corn ethanol and biomass based diesel. It is not an accident that these two technologies have seen robust growth and an ability to easily meet the volumetric goals set by RFS for their technologies. All other volumetric goals are subject to annual review by EPA and the cellulosic mandate has typically been waived in part or in its entirety. This does little to incent investment in advanced biofuel production. The cellulosic volumetric "carve-out" is also unhelpful to the RFS in that it favors a certain category of feedstock over others without regard to technological feasibility or performance in meeting the programs goals for greenhouse gas (GHG) reductions.

An alternative approach would be to simplify the RFS by eliminating the multiple fuel categories (advanced, cellulosic, biomass based diesel) and simply rewarding (through higher RIN value) an eligible product based on energy content, infrastructure compatibility and improved GHG performance when compared to a petroleum baseline. This would also allow easy expansion of RFS eligibility to any other product (such as a heating oil, bunker oil, or chemical) that also displaces petroleum and delivers improved performance. Unlike the present RFS, such as system would also incentivize incremental improvement in GHG performance by providing increasing RIN value for those improvements.

Question 9: What is the scale of the impact of the RFS on international agricultural production and global land use changes?

While this is a very broad topic with likely widely divergent views, we would like to bring two points to the attention of the Committee. First, a March 2013 study by the World Bioenergy Association pointed out that while biofuel production has had a minimal impact on agricultural prices, "higher commodity prices have many positive effects in the global agricultural commodities market. They provide strong incentives for increased returns for farmers for example in developing countries, thus offering important development benefits."[3] *Second, a 2011 study found that "the US historical data do not indicate that iLUC occurred within the 48*

[2] Bio Economic Research Associates, *U.S. Economic Impact of Advanced Biofuels Production: Perspectives to 2030,* February 2009.

[3] World Bioenergy Association, *Biofuels for Transport,* March 2013. www.worldbioenergy.org.

contiguous states as a result of US biofuel production."[4] *We certainly believe that there is credible evidence to support both of these conclusions.*

Once again, we appreciate the opportunity to comment and hope this information is beneficial to the Committee as it continues its review of the RFS. If there are any questions please do not hesitate to contact me at (202) 507-1316 or david_hitchcock@virent.com.

Sincerely,

David M. Hitchcock
VP, Government Affairs

[4] Kim, S., & B.E. Dale, B.E. 2011. "Indirect land use change for biofuels: testing predictions and improving analytical methodologies" *Biomass and Bioenergy*. In Press. doi:10.1016/j.biombioe.2011.04.039.