Testimony on the U.S. Renewable Fuel Standard before the U.S. House of Representatives Committee on Oversight and Government reform, Subcommittee on the Interior and the Subcommittee on Healthcare, Benefits, and Administrative Rules

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The U.S. has had various policies in effect to promote greater use of biofuels since 1978 [1]. The most important current policy is the Renewable Fuel Standard (RFS), the current version of which was created in 2007 [2]. In general biofuels policies and the RFS have had three major objectives [3]:

- Enhance rural incomes and well being
- Reduce oil imports and dependence on foreign oil
- Reduce greenhouse gas (GHG) emissions

My assessment is that the RFS has been successful in achieving all three objectives. It has helped increase rural incomes; it has helped reduce oil imports; and it has helped reduce GHG emissions.

In the rest of this note, I will discuss implementation of the Renewable Fuel Standard, compare the consequential life cycle analysis and additional carbon approaches to estimating GHG emission impacts for biofuels, and describe the possible impacts of biofuels policies on developing countries. I conclude with some thoughts on possible future directions for U.S. energy policy.

Renewable Fuel Standard

Despite the success of the RFS in achieving its objectives, it has been controversial with strong interest groups aligned for and against the RFS. The U.S. Environmental Protection Agency (EPA) administers the RFS. The RFS as created by Congress [2] contains four categories of biofuels – biodiesel, cellulosic biofuels, other advanced biofuels, and conventional biofuels. There is an overall biofuel mandate and also levels for each category of biofuel, or buckets as I call them. It is also a nested structure as illustrated in Figure 1, which shows the 2022 target levels. Biodiesel only can be used to meet the requirement of the biodiesel bucket, but biodiesel can also be used to satisfy the other advanced bucket or the conventional bucket. The same structure holds for cellulosic biofuels. Only cellulosic biofuels can be used to meet that requirement, but cellulosic biofuels can also be used to meet the requirements for other advanced or conventional biofuels. Corn ethanol can only be used to meet the requirement for conventional biofuels, which is really the difference between the overall mandate and the separate mandates for the other categories. There is no direct mandate for corn ethanol.

Each fall, EPA is expected to announce the mandate levels for the following year. It also specifies the share of the total mandate that is allocated to each obligated party based on their market share in the product markets. EPA has found it difficult to maintain the schedule, and has at times fallen behind. In November 2015, EPA did announce its final numbers for 2014, 2015, and 2016, and those are contained in Table 1.

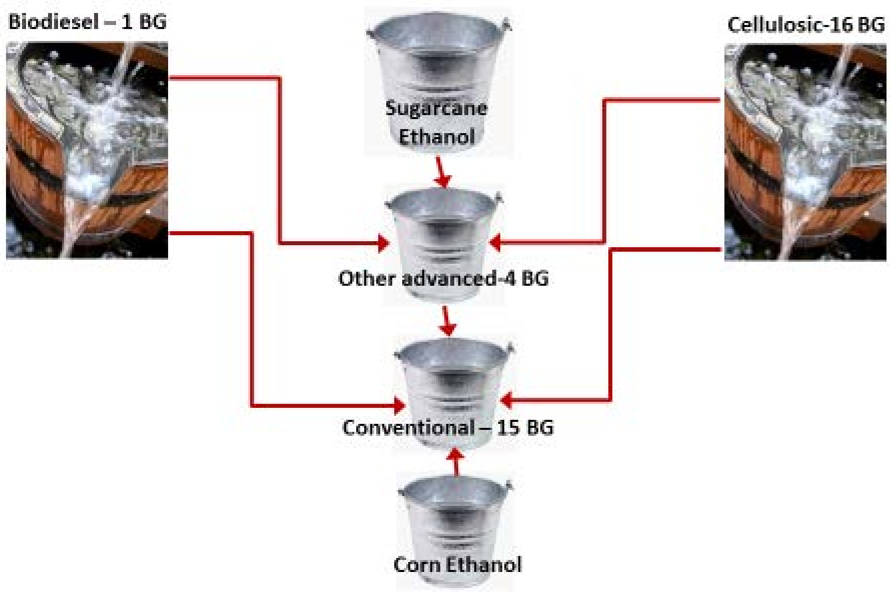

Figure 1. Nested Structure of the U.S. Renewable Fuel Standard

The figures for 2014 essentially ratify what happened that year. The more important figures are the levels announced for 2016. My interpretation of the EPA approach in reaching these levels is explained below:

- **Cellulosic** – EPA essentially used data on existing and projected future plants and set the RFS mandate to match the projected production levels. In other words, it is a "build it and we will come" approach. The projected production levels are very small relative to the levels in the original RFS. For example, in 2016, the cellulosic RFS level was 4.25 bil. gal., and the actual 2016 RFS level is 0.23 bil. gal., or 5.4% of the original mandate.
- **Biodiesel** – the RFS level for biodiesel grows steadily over the period. The original Congressional mandate was at least 1 bil. gal., and the 2016 level reaches 1.9 bil gal. EPA believes that the market can provide and absorb significant increases for biodiesel. Additional biodiesel can be used in the other advanced category as well.
- **Corn (conventional) ethanol** – EPA allows growth in the implied corn ethanol mandate. Essentially the EPA believes the blend wall is a strong barrier, which must be taken into consideration in fixing the final level. However, my interpretation is that they also respect the intent of the original RFS mandate to pull in more ethanol. For 2016, EPA set the level at 14.5 bil. gal., which assumes some consumption beyond the E10 blend wall. In other words, EPA sought to achieve

balance between the reality of the blend wall and the intent of the RFS to pull in more biofuels.

- **Other advanced biofuels** – EPA set the 2016 level at 0.53 billion gallons. Ethanol from sugarcane can be used in this category. Also, biodiesel and cellulosic biofuel can be used here. So, in fact, even more biodiesel could be used to meet the other advanced mandate.
- **Total renewable biofuels** – the total required biofuels grows about 1.2 billion gallons between 2015 and 2016.

How should we interpret the EPA announcement? Essentially, EPA attempted to find a balance between arguments pro and con on the RFS. Biodiesel grows far beyond the original number in the RFS. For corn ethanol, EPA accepted the arguments that the blend wall is a legitimate barrier. Their 2016 level requires some growth of E85/E15, but it does not reach the original 15 bil. gal. mandate. If the higher mandate does not pull in additional corn ethanol, there are enough carry-forward RINs in 2016 to make up for the shortfall. The EPA final numbers represent a reasonable compromise position.

Table 1. EPA Final Numbers for 2014, 2015, and 2016 (bil. gal.)

Fuel category	2014	2015	2016
Cellulosic	0.033	0.123	0.23
Biodiesel	1.63	1.73	1.90
Other advanced	0.192	0.162	0.53
Total advanced	2.67	2.88	3.61
Conventional	13.61	14.05	14.50
Total renewable	16.28	16.93	18.11

Notes: All volumes are ethanol equivalent except biodiesel, which is actual.

The other advanced category is total advanced - 1.5*biodiesel - cellulosic. This presentation of the RFS levels differs from the way EPA communicates the levels, but the bottom line is the same.

EPA indicated that they are committed to releasing the final RFS numbers in the future in November of each year. Thus, they intend to be on schedule in the future.

Consequential life cycle analysis versus additional carbon

Greenhouse gas (GHG) impacts of biofuels are usually estimated with either attributional or consequential life cycle analysis or a combination of the two. The most common approach is consequential life cycle analysis. The consequential life cycle analysis approach calls for estimating the GHG consequences of biofuels technologies or policies [4, 5] with a system boundary that includes all important impacts. Several authors have proposed the use of an additional carbon approach to (GHG) emission calculations instead of the attributional or consequential life cycle analysis approaches. The additional carbon approach essentially argues that the carbon sequestration done by biofuel feedstock plants cannot be counted as savings because the plants would have been grown anyway [6-9]. Both approaches imply a "with-without" analysis, but implementation of the approaches would be quite different.

The additional carbon assumption is well expressed by Searchinger and Heimlich [9]:

> The world's lands are already growing plants every year and these plants are already being used. (p. 16)

In other words, the assumption is that every hectare of land that goes to biofuels deducts from other uses. If we use corn for ethanol, we have less corn to eat. The consequential life cycle analysis approach normally uses as its system boundary the entire domain or impact area of any given policy [10]. Examples are the California Low Carbon Fuel Standard [11] and the US Renewable Fuel Standard [12]. There is no regulatory body in any country that employs the additional carbon approach.

Another related argument often embedded in the additional carbon approach is that it would be better to use any available land to sequester carbon than to produce biofuels to displace fossil carbon. In addition, the food-fuel argument also often gets included in additional carbon reports [9]. However, these are different arguments. There have been several studies that compare forest sequestration with biofuels and biopower [13]. Some use a carbon tax with endogenous decisions on the amount of sequestration and biofuels that will be produced over a range of carbon prices [14]. In fact, most economists would argue that pricing carbon is the efficient way to determine the extent to which biofuels, sequestration, solar energy, etc. would come into the market. The additional carbon approach makes the assumption that all land is being used, that any plant material use for biofuels necessarily means less availability elsewhere, and that sequestration is more efficient than biofuels. None of these assumptions are adequately justified by the proponents.

The consequential LCA approach often makes use of computable general equilibrium models to estimate the impacts of what are called market mediated responses to the higher demand from biofuels [15]. Possible responses included the following:

- With a higher price, consumption (quantity demanded) normally would fall.
- With a higher price for this commodity, there can be switching among crops so that more of this crop is produced and less of other crops.
- With a higher demand for this commodity, more cropland can be needed to meet that increased demand, and this cropland can come from pasture or forest converted to cropland. This is referred to as a change on the extensive margin.
- With the higher commodity demand, the existing cropland might be farmed more intensively such as via double cropping or irrigation or other investments in increased productivity and yield. This is referred to as a change on the intensive margin. An increase in intensive margin on existing cropland reduces demand for land conversion (from either forest or pasture to cropland).

- With higher demand for this commodity for biofuels, there can be impacts on international trade of the commodity and of other substitute commodities. In other words, a biofuel demand increase in country A can have repercussions anywhere in the world because the agricultural commodity markets are global.

An important difference between the two approaches is that the consequential LCA approach is driven by market forces, whereas the additional carbon approach assumes that any incremental demand reduces availability elsewhere. We can take two examples from the US to illustrate the difference. Prior to the biofuels era (before 1980 in the US), both the US and the EU had programs to set aside agricultural lands because market forces produced “too much” of the commodities. To participate in farm programs in both the US and EU, farmers had to take part of their land out of production. Since then the US and EU set aside programs (with different rules) have been modified or eliminated. In the period between 2006 and 2012 (the biofuels boom) corn production in the US increased substantially, but total cropland area hardly changed. Corn substituted for other crops. Production also changed in other world regions, and there was more double cropping than before. In fact, 213 million acres was added to the global cropland base between 2003 and 2012 for production of cereal grains, cotton, and oilseeds [15]. Not all or even most of this increase was driven by biofuels. The point is that these changes were driven by market forces, and there was no one-for-one drop in other uses as biofuels production increased.

Another important difference between the two approaches concerns implementation feasibility. The consequential LCA approach is being used by US EPA and by CARB. While there is large uncertainty in the land use impacts and associated emissions, the approach can be implemented. It is hard to see how the additional carbon approach could be implemented. It relies on totally unjustified assumptions on what is additional carbon. Once one departs from the simple assumptions that none of the carbon is additional, then implementation becomes very problematic. Since it does not rely on market mechanisms, there is no obvious way to consistently determine what carbon is additional.

Biofuels impacts on the developing world

Another important issue that has arisen with respect to biofuels concerns the extent to which biofuels policies and production have led to food price increases, and, to the degree they have, what have been the consequences on developing countries. There have been many studies on these issues, and the results vary significantly [16-19]. See [16] for an annotated bibliography of many of the papers in this area through 2008.

There is no doubt that biofuels programs have had some impact on commodity prices. There are many other drivers of changes in commodity prices such as changes in global supply and demand for the commodities, weather, and changes in exchange rates, among others [16, 20-22]. To the extent that biofuels have led to higher commodity prices, the extent to which that translates to higher food prices varies by state of development of the economy. In the U.S., citizens spend less than 10% of their disposable income on food, and about half of that is spent on food away from home. The U.S. diet contains more processed foods, so raw commodity price changes do not translate to significant food price changes. On the other hand, in countries like Sri Lanka and Bangladesh, more than 60% of disposable income is spent on food, and much of that on raw commodities rather than processed foods. So it is clear that higher commodity prices induced by biofuels or by any of the other drivers adversely impact urban consumers in developing countries.

What is often overlooked in the commodity price story with respect to developing countries is the impacts on developing country farmers. Urban consumers get the attention when they march in the streets to protest higher food prices, and they have more political power than rural inhabitants. However, it is very important to consider the impacts of higher commodity prices on rural areas in developing countries [22]. The World Bank says that 70% of the world's poor live in rural areas in developing countries and derive their primary livelihood from agriculture. Higher commodity prices have the potential to increase rural incomes and reduce rural poverty as farmers receive more for what they produce. Even rural laborers can see higher incomes as higher rural productivity and incomes help increase rural wages.

One of the impediments in achieving this rural supply increase in response to higher commodity prices is that some developing countries have tried to keep the higher prices from being transmitted to their domestic economy, again to protect urban consumers. To the extent they succeed in preventing price transmission, the supply response and increased rural well-being will be muted. However, to the extent that the higher commodity prices are transmitted to rural areas, it is clear that rural incomes can increase.

Joy Clancy provides a careful analysis of the issue of the possible relationships between biofuels and poverty [23]. She stresses that biofuels can either be pro-poor or can lead to increased poverty. She lays out policies and approaches to ensure that biofuels are pro-poor.

In some quarters, the "land-grab" issue also has been linked with biofuels, although the link is usually not clear. Much of the land grab began following the agricultural commodity price spikes in 2008, and most of it is linked to food and feed crops, not biofuels. It often is facilitated by corrupt local politicians who sell the rights to land to foreigners often for the production of food. The evidence is clear that biofuels are not the primary driver of the land grab.

Road to the future

The scientific community has concluded that global warming is real and is caused by human intervention. To prevent major costs being imposed on our economy and the global economy, we need to take action to reduce GHG emissions. Almost any economist would argue that a carbon tax is the most efficient way to stimulate actions that lead to reduced GHG emissions. However, to date it has been impossible to obtain consensus on that approach in Washington. A carbon tax is a market based approach to correcting the external effects of increased GHG emissions. It is a way of pricing the emissions so that all of us take into consideration the carbon content of the goods we use in the economy. It leads to the most efficient and least cost path to reducing GHG emissions. Many corporations have endorsed emission reduction policies including a carbon tax. A carbon tax can be made revenue neutral so that it does not increase the size of government.

However, Washington continues to favor a regulatory approach instead of a market mechanism. Thus we have CAFE standards for fuel economy, a Clean Power Plan for electricity emissions, and a Renewable Fuel Standard for reducing emissions of automotive fuels through use of biofuels [24, 25]. So long as we continue to prefer the regulatory approach in lieu of a market based carbon pricing approach, then I think the Renewable Fuel Standard and the other regulations just mentioned are appropriate and effective ways to move our economy towards lower GHG emissions.

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Name: Wallace E. Tyner

1. Please list any federal grants or contracts (including subgrants or subcontracts) you have received since October 1, 2012. Include the source and amount of each grant or contract.

Grant Title	Granting Agency	Start Date	Ending Date	Amount
Economic, Agronomic and Environmental Benefits of Cover Crops for New and Established Users	USDA Natural Resources Conservation Services	11/1/2013	11/30/2016	$ 329,584
Techno-economic and Lifecycle Analysis of Alternative Aviation Biofuels Supply Chains	Federal Aviation Administration	7/14/2014	8/31/2016	$ 250,000
Techno-economic and Lifecycle Analysis of Alternative Aviation Biofuels Supply Chains	Federal Aviation Administration	7/14/2014	8/31/2016	$ 230,000
GTAP Model and Data Base Modification to Better Handle Cropping Changes on the Intensive Margin	Federal Aviation Administration	2/19/2015	2/29/2016	$ 110,000
Soil Health Economics: Measuring and Validating the Economic Benefits and Costs of Soil Health Practices	USDA Natural Resources Conservation Services	10/1/2015	9/30/2018	$ 356,704

2. Please list any entity you are testifying on behalf of and briefly describe your relationship with these entities.

NONE

2. Please list any federal grants or contracts (including subgrants or subcontracts) received since October 1, 2012, by the entity(ies) you listed above. Include the source and amount of each grant or contract.

NONE

I certify that the above information is true and correct.
Signature: Wallace E. Tyner

Date: January 20, 2016

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Professor Tyner is an energy economist and James and Lois Ackerman Professor of Agricultural Economics, Purdue University. He received his B.S. degree in chemistry (1966) from Texas Christian University, and his M.A. (1972) and Ph.D. (1977) degrees in economics from the University of Maryland. Professor Tyner's current research interests are in the area of energy, agriculture, and natural resource policy analysis and climate change. He has over 330 professional papers in these areas including three books and 110+ journal papers, published abstracts, and book chapters with over 4,200 citations.

His past work in energy economics has encompassed oil, natural gas, coal, oil shale, biomass, ethanol from agricultural sources, and solar energy. His current research focuses on renewable energy policy issues, national energy policy, and climate change. He is doing techno-economic analysis for aviation biofuels and work on life cycle analysis and land use change related to aviation biofuels as well.

In June 2007, Senator Richard G. Lugar of Indiana named Tyner an "Energy Patriot" for his work on energy policy analysis. In 2009 he received the Purdue College of Agriculture Outstanding Graduate Educator award and was part of a group that received the College Team award for multidisciplinary research on biofuels. In 2013, he received the Distinguished Graduate Teaching award from the Agricultural and Applied Economics Association. In 2011, he served as Co-chair of the National Academy of Sciences Committee on Economic and Environmental Impacts of Biofuels. In 2015, he received the Purdue Morrill award for career accomplishments that have had impact on society and the Honorary Life Member award (their highest honor) from the International Association of Agricultural Economists.