Pity the poor biofuels policymaker: Reconsidered

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The purpose of this note is to clarify three significant misrepresentations published in a Policy Update (Tyner, 2013) titled "Pity the poor biofuel policymaker." The stated aim of the Policy Update (Tyner, 2013) was to "review some of the literature on three key biofuels issues": land-use change (LUC), fossil fuel prices and food prices impacts. However, Tyner (2013) repeatedly cited our publication, "Global economic effects of US biofuel policy and the potential contribution from advanced biofuels" (Oladosu et al., 2012). The following compares statements made in the Policy Update (Tyner, 2013) with the substance of what was published by Oladosu et al. (2012).

1. **Land-use change impacts of biofuels**: Tyner (2013) states: "Oladosu *et al.* from the Oak Ridge National Laboratory (ORNL) reached the dubious (sic) conclusion that adding biofuels demand to food and feed demands actually reduces <u>global cropland area</u>."[emphasis added]

   The above statement is not found in Oladosu et al (2012) because it was never stated or implied. The purpose of the simulations in Oladosu (2012) was to examine the effects of RFS2 cellulosic production targets while endogenously linking fossil fuel and biofuel markets in a dynamic model:

   > "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." (*Oladosu et al, 2012, Page 708, column 1, paragraph 2*)

   The summary of land-use change results from the "Conclusions" of Oladosu et al (2012) states, "One additional finding from this study is that reductions in <u>agricultural land</u> use in oil export-dependent economies more than offset increases elsewhere." (*Oladosu et al, 2012, Page 721, column 1, paragraph 3*) [emphasis added].

   Those familiar with land classification systems understand that "<u>cropland area</u>" is distinct from and a component of the larger class, "<u>agricultural land,</u>" the latter being defined in Oladosu et al. (2012):

   > "demand for agricultural land…is the sum of land use over all crops, forestry and pasture activities." (*Oladosu et al, 2012, Page 706, column 2, paragraph 2*).

   Thus, LUC results in Oladosu et al. (2012) reflected the net change in area for aggregate "agricultural land" including all three components, c*ropland, forestry land, and pasture land*, not just cropland. The explicit definition in Oladosu et al. (2012) was omitted in the Policy Update, along with the explanation that while agricultural land use expanded in some regions, the expansions were offset by declines in agricultural land use in other regions.

Oladosu et al. (2012) focused on agricultural land instead of cropland because this reduces some of the inherent uncertainties surrounding global land use/land cover for individual classes (cropland, grassland, and forest) which have been shown to generate spurious conclusions about land-use change (e.g. Feddema et al. 2005; Grainger 2008; Kline et al., 2013; Kline et al. 2011). Indeed, studies by Tyner and colleagues show that net agricultural land use change would be close to zero once, as in Oladosu et al (2012), their estimates of changes in cropland and pastureland are combined (see Taheripour, Zhao and Tyner, 2017, for example).

The above statement from the Policy Update further misleads readers by failing to mention that the results in Oladosu (2012) were based on a dynamic model with a simulation period spanning 2001 to 2030. Net agricultural land-use changes in the simulation results presented in Oladosu et al. (2012) show expansion of agricultural area between 2001 and 2010, contradicting the strawman notion in Tyner (2013) that "biofuels reduce total land area needed for crops." By 2010, annual US production of conventional biofuels reached 13 billion gallons or about 83% of the maximum allowed level of 15 billion gallons under the RFS2 policy. Thus, most of the period over which net agricultural land-use change declined per results from our paper (Oladosu et al. 2012) corresponds to years with simulated increases in advanced biofuels from cellulosic residues. The declining pressure for agricultural land expansion occurs as reliance on advanced cellulosic biofuels increases in the later years. These results are consistent with the results of "improved" simulations by Tyner and colleagues for cellulosic biofuels produced from crop residues, even within their static modeling framework (Taheripour, Zhao and Tyner, 2017). In addition, when Taheripour, Zhao and Tyner (2017) incorporated more realistic estimates of cropland intensification their estimates of the LUC impacts of conventional ethanol declined by more than 50%, relative to a case that ignores intensification, and is nearly 90% lower than initial LUC estimates presented by Tyner and colleagues in 2009 (Tyner, Taheripour, Baldos, 2009).

Factors behind the dynamic patterns of land-use change are discussed in Oladosu et al. (2012), and include drivers of LUC that were unaccounted for in previous studies. Prior analyses generally relied on a static modeling framework that abstracts from the dynamic effects of biofuels on the oil market, whereas the express goal of the RFS2 policy is for biofuels to directly displace oil in transportation fuels over time. The importance of dynamics in the LUC impacts of biofuels, as considered in Oladosu et al. (2012), can also be seen in a recent study by Tyner's colleagues. Golub et al. (2017) simulated the land-use change impacts of conventional ethanol production in the US within a dynamic model, and presented results on the pattern of global cropland change over time. Although differences in the model and results persist when compared to our work, Golub et al. (2017) found that the land-use change impacts of biofuels decline over time as in Oladosu et al. (2012). Specifically, their estimates of the global cropland-use impact of US ethanol production declined from 0.15 hectares/thousand gallons in 2007 to 0.05 hectares/ thousand gallons by 2016 and to 0.02 hectares/thousand gallons by 2030. Thus, an important contribution by Oladosu et al. (2012) was to illustrate the dynamic LUC effects of biofuel policies due to interactions among agricultural markets, fossil energy markets and the rest of the economy. Yet, this and other important findings were ignored in the Policy Update (Tyner, 2013) in favor of misleading statements.

2. **Oil price impacts of biofuels**: The Policy Update (Tyner, 2013) states: "The ORNL finds that US biofuel production can cause a decrease in world oil price of 3–7% [8]. Current US biofuel production is less than 1 million barrels/day and world oil production is approximately 88 million barrels/day [16]. It is hard to believe that US biofuel production would have such a large impact on global oil price."

   In this case, the Policy Update (Tyner, 2013) misdirects readers with a general "it is hard to believe" statement, rather than provide a quantitative assessment of the oil price impacts estimated in Oladosu et al (2012). A quantitative assessment illustrates that the Oladosu et al. (2012) estimates are reasonable based on several criteria. First, the simulated reduction in world oil price of 3-7% reflects the dynamic impacts of the US RFS2 target of 36 billion gallons per year, rather than the effects of the 1 million barrels/day (about 12 billion gallons equivalent) that was "current" at the time of publication. For the level of U.S. biofuel production at the time of the publication, the applicable oil price result is a decrease of about 3%. Second, underlying assumptions about the economy and global energy markets were clearly documented in Oladosu et al. (2012) and reflect the price interaction mechanisms that accompany a displacement of oil with biofuels. Third, the reasonableness of our estimated oil price impact can be shown by evaluating the global oil supply price elasticity implied by the results as follows:
   1. Global oil production of 88 million bpd (bpd = barrels per day)
   2. U.S. biofuel production of about 0.9 million bpd (the oil equivalence is about 0.7*0.9 = 0.63 million bpd to account for the lower energy content of ethanol).
   3. Recognizing that the displacement of oil with biofuels under the RFS2 standards shifts the global oil demand curve, the global oil supply elasticity implied by the result in Oladosu et al (2012) can be calculated as: (-0.63/88)*(1/-0.03), which is approximately 0.24.

   The above estimate of the global oil price elasticity of supply is near the mean of empirical estimates in the literature (see Taghizadeh and Yoshino, 2014, for example). To emphasize the basis for the oil market impacts of biofuels, Oladosu et al. (2012) notes that regional oil supply curves were estimated from empirical data:

   > "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." (*Oladosu et al, 2012, Page 721, column 2, paragraph 3*).

   Therefore, the oil price impact results in Oladosu et al. (2012) were not only "believable", but were based on empirical data, and reflect clearly stated assumptions about future energy markets and the economy.

3. **Food price impacts of biofuels**: The Policy Update (Tyner, 2013) states: "An ORNL paper concluded that biofuels cause a food price increase of less than 1% [8], whereas Abbott *et al.* demonstrated that biofuels were a significant contributor to the commodity price increase of 2011." As with the prior commentaries, the Policy Update (Tyner, 2013) misrepresents the results from simulations in Oladosu et al (2012) with a general statement. A more constructive review would consider quantitative comparisons to the literature and provide explanations for the widely diverging

estimates of biofuel effects on food markets. A recent meta-analysis (Condon et al., 2015) showed that estimates of the food price impacts of biofuels cover a wide range, including negative price effects, as well as estimates by Tyner (and colleagues) that were as high as 84% (Tyner and Taheripour, 2008; Tyner et al., 2010). The meta-analysis by Condon et al. (2015) and reviews by other studies have shown that the range of estimates can be traced to systematic factors, including differences in data and methods, among others (see Oladosu and Msangi, 2013; Kline et al., 2017). Estimates of biofuel's effects on food prices in Oladosu et al (2012) represent the sum-total of a clear set of factors that were documented and considered in the paper.

In conclusion, science is about asking the right questions, collecting data, and testing hypotheses based on that data. Science also involves peer review, with sometimes strong but respectful disagreements. However, there should be no room for misrepresentations of other people's efforts and results. It is instructive that Tyner (2016), in testimony to the US Congress, stated that "…there is large uncertainty in the land-use impacts…" Similarly, Oladosu et al. (2012) states, "Despite the copious research into the land-use implications of biofuel policy, insights into the local-level effects remain limited." Readers are invited to review the discussion in Oladosu et al. (2012) and verify for themselves that the study is thorough, and acknowledges the limitations of available data and other uncertainties.

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