NJAS - Wageningen Journal of Life Sciences 77 (2016) 19–24

Contents lists available at ScienceDirect

NJAS - Wageningen Journal of Life Sciences

journal homepage: www.elsevier.com/locate/njas

Prices matter: Analysis of food and energy competition relative to land resources in the European Union☆

Justus Wesseler*, Dušan Drabik

Agricultural Economics and Rural Policy Group, Wageningen University, De Leeuwenborch, Hollandseweg 1, NL-6706 KN Wageningen, The Netherlands

ARTICLE INFO

Article history:
Received 29 August 2015
Received in revised form 7 March 2016
Accepted 16 March 2016
Available online 29 March 2016

Keywords:
European Union
Biofuels
Food versus fuel debate
Resource efficiency

ABSTRACT

We advance a conceptual framework to put the debate about food versus fuel in the European Union into perspective. We show that many of the problems identified for the food and bioenergy production in the European Union have been priced via several rules and regulations, including water use, fertilizer and pesticide use, and protection of habitats. Therefore, products produced at lower costs (including environmental costs) require fewer resources and can be considered more environmentally friendly. Our results suggest that, from a resource efficiency point of view, the European Union should consider importing more biofuels and biofuel feedstocks from other countries.

1. Introduction

Production of biofuels has become a controversial topic of academic and public debate over the past decade. By providing tax credits and tax exemptions and by introducing minimum blending requirements for biofuels, the United States and the European Union embarked on significantly promoting the use ethanol and biodiesel in the early 2000s.[1] The United States and the European Union implemented their biofuel policies with the stated objectives of reducing greenhouse gas emissions and the dependence on imported oil in the transport sector; promoting the security of energy supply by increasing domestically produced energy; promoting technological development and innovation; and providing opportunities for employment and regional development in rural and isolated areas.

However, as the production of biofuels was increasing worldwide so was the intensity of arguments pointing to its adverse effects. Perhaps, the two most distinguished streams of critique are the food versus fuel argument and the adverse environmental effects of biofuels production.

The food versus fuel debate centers on whether agricultural crops should be diverted to biofuels to the detriment of food supply. On the other hand, the negative environmental effects of biofuel policies include various "leakages" of carbon emissions (e.g., in the land market—the indirect land-use change effect; or in the fuel market—the indirect output use change effect) as well as other adverse effects such as loss of natural habitats or increased fertilizer and pesticide use due to a higher intensity of crop production.

The argument we want to make in this paper is that the debate about food versus fuel is often misleading. The reason for this is that many of the problems identified for food and bioenergy production in the European Union, on which we focus, have already been priced via several rules and regulations, including water use, fertilizer and pesticide use, protection of habitats, and sustainability of biofuels. Hence, products produced at lower costs (including the environmental cost) require fewer resources and can be considered more environmentally friendly.

To illustrate, consider the EU Fuel Quality Directive (FQD)[2] that requires an overall reduction in the greenhouse gas intensity of the fuels used in vehicles by 6 percent by the year 2020 relative to 2010. The FQD stipulates minimum carbon savings of biofuels relative to fossil fuels. Such a regulation affects the relative price of biofuels and fossil fuels. Thus, the observed market prices of biofuels and agricultural commodities implicitly reflect additional costs related to complying with the environmental and other regulations

☆ We would like to thank two anonymous reviewers and the guest editor of this issue, Liesbeth Dries, for their helpful comments and suggestions. The usual disclaimer applies.

* Corresponding author.
E-mail address: Justus.Wesseler@wur.nl (J. Wesseler).

[1] Some ethanol production in the United States existed also before 2000.

[2] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0030&from=EN

http://dx.doi.org/10.1016/j.njas.2016.03.009
1573-5214/

both in the European Union and worldwide. On the assumption that market participants behave rationally, the observed market prices stem from optimal participants' responses to a given institutional environment.

Therefore, instead of discussing whether agricultural crops should be used in food or fuel production, we propose to compare production costs across products and countries to determine the resource efficiency. One implication of this approach for the European Union is that imports of biofuels/biofuels feedstocks from abroad might be preferred from a resource use efficiency point of view.

2. Historical overview of the EU biofuel policies

The policies governing the production and consumption of biofuels in the European Union are complex. The complexity has three main dimensions. First, the biofuels production and consumption are regulated by the Renewable Energy Directive (RED) and by the Fuel Quality Directive (FQD). Second, three EU institutions shape the EU biofuel policies: the Commission, the Parliament, and the Council. In addition, a number of pro- and anti-biofuel lobby groups are active in (re)designing biofuel policies. For example, many EU biodiesel producers are associated in the European Biodiesel Board (EBB). Third, although the EU directives state general objectives to be achieved and principles to be followed at the EU level, the actual implementation of the biofuel legislation differs across the 28 EU Member States.

Large-scale biofuels production in the European Union started only after the EU Parliament and the Council passed the Directive 2003/30 on the promotion of the use of biofuels for transport in May 2003. The objectives of this Directive were to replace diesel and gasoline in the transportation sector to contribute to (*i*) meeting the EU climate change commitments, (*ii*) achieving environmentally friendly security of energy supply, and (*iii*) promoting renewable energy sources. The Directive stipulated a target of 5.75 energy percent by 2010.

It is important to notice that the targets in the Directive 2003/30 were (and to this date are) expressed as an energy share, as opposed to a volumetric share used in other countries (e.g., the United States or Brazil). Most importantly, however, the targets were not binding. This implies that as long as a Member State was able to explain why a lower energy share of biofuels had been achieved, no consequences followed. To illustrate the non-binding character of the target, note that the share of biofuels in total transportation fuels in the European Union reached 1.02 percent in 2006 and 3.9 percent in 2010,[3] and 22 out of 27 EU Member States failed to achieve their target for 2010 (European Commission 2013).

Another important piece of legislation affecting the production and consumption of biofuels in the European Union is the Fuel Quality Directive of 2009. The FQD addresses the reduction in life cycle greenhouse gas emissions of transportation fuels by 6 percent by the year 2020 as compared to 2010. With respect to biofuels, it specifies criteria that need to be met for biofuels to count toward the mandatory consumption targets.

Perhaps the most important of these criteria is a requirement that biofuels should save at least 35 percent of greenhouse gas emissions compared to the fossil fuels they are to replace. This threshold increases to 50 percent starting from January 1, 2017. Moreover, from January 1, 2018 the saving shall be at least 60 percent for biofuels produced in plants that started production on or after January 1, 2017. It is important to note, however, that the greenhouse gas emissions savings above do not take into account carbon emissions from land use change—a topic that gave rise to a heated debate on biofuels in the European Union after 2012.

In addition to emissions reduction, the FQD also specifies requirements for the origin of biofuel feedstocks. The energy from biofuels can only be counted toward a national target if the feedstock or a biofuel complies with additional sustainability criteria detailed in the FQD. For example, the feedstock cannot be obtained from land with a high biodiversity value (e.g., primary forest and other wooded land of native species); from areas designated for nature protection or for protection of rare, threatened, or endangered ecosystems; from highly biodiverse grassland that is natural or rich in species; from land with high carbon stock (e.g., wetlands) or from peat. Moreover, the FQD allows imports of biofuels or biofuel feedstocks only from countries that have ratified important international conventions such as the Convention on International Trade in Endangered species of Wild Fauna and Flora; the Cartagena Protocol on Biodiversity; or conventions of the International Labor Organization.

The food commodity price booms of 2008 and 2011 and the intensifying food versus fuel debate have been an impetus for the reform of the EU biofuel policy. In October 2012, the European Commission proposed to reform the EU biofuel policy (represented by the RED and FQD directives).[4] In the proposal, the Commission assigned indirect land use change (ILUC) factors to different biofuels but failed to account them for the climate performance of biofuels. Thus, the ILUC factors are currently used only for reporting purposes. In recognition of adverse inflationary effects of first-generation (i.e., land-based) biofuels on food commodity prices, the Commission also proposed to cap the use of these biofuels to 5 energy percent. Environmentalists, such as Transport and Environment—a Brussels-based environmental organization—were not happy with this proposal as it did not mean complete abolition of biofuels produced from food crops.

The 2012 EU Commission proposal also specified weights for biofuels feedstocks to be used in counting the contribution of various biofuels toward the overall target. For example, the energy content of biofuels from used cooking oil, animal fats, or non-food cellulosic material should be counted twice, and that of biofuels from feedstock like algae, straw, or biomass fraction of industrial waste should be counted four times. First-generation biofuels have a contribution factor of one.

The reshaping of the EU biofuel policy continued in July 2013 when the European Parliament's Environmental Committee voted for the inclusion of the ILUC factors into the RED and for capping all first-generation biofuels at 5.5 percent. Later in September 2013, the European Parliament voted to cap the first-generation biofuels at 6 percent and placed a 2.5-percent minimum requirement to be achieved by 2020 for advanced (third-generation) biofuels from, for example, seaweed or certain types of waste [11]. In June 2014, the Council of energy ministers decided to cap the use of land-based biofuels to 7 percent and to put a 0.5-percent floor for advanced biofuels.[5] Importantly, the Council did not propose to include ILUC estimates in sustainability criteria for biofuels.

3. Food versus fuel debate

3.1. Agricultural land availability

Large-scale global production of biofuels requires agricultural feedstock to be converted into motor fuels. Although in the long-run the supply of productive agricultural land is limited, an FAO study

[3] http://ec.europa.eu/agriculture/markets-and-prices/medium-term-outlook/2015/tables_en.pdf (based on Table: Biofuels balance sheet for the EU, 2005–2025 (million tonnes oil equivalent))

[4] http://ec.europa.eu/clima/policies/transport/fuel/docs/com_2012_595_en.pdf

[5] http://gr2014.eu/sites/default/files/indirect%20land-use%20change_1.pdf

by Alexandratos and Bruinsma [2] finds that 1.4 billion hectares (960 million hectares in developing countries) of prime (very suitable) and good (suitable and moderately suitable) land is still available[6]; this additional area is almost equal to the 1.6 billion hectares currently under cultivation. Fritz et al. [15] reported an area of land for bioenergy production in the range of 320–1411 million hectares. Using high-resolution satellite imagery, they adjust the original estimates downwards to the range of 56–1035 million hectares.

Despite the availability of agricultural land, it should be stressed that productive land supply is very unevenly distributed. For example, some 85 percent of the 960 million hectares in developing countries are located in sub-Saharan Africa and Latin America. Moreover, much of the additional land faces problems related to low fertility, soil nutrient mining, soil erosion, salinization of irrigated areas, lack of infrastructure, or ecological fragility [2].

3.2. Land conversion and environmental externalities

Conversion of some types of land cover (e.g., forests or pastures) into an arable land for production of biofuel feedstock can come at significant costs. These costs do not only include the private marginal cost of converting and cultivating additional natural areas but also include marginal external costs associated with environmental damages such as carbon emissions related to land conversion; loss of biodiversity due, for example, to clearing of rain forests; land degradation due to erosion; the unaccounted-for health costs due to food insecurity caused by high commodity prices; or public health effects related to ecosystem degradation (such as additional malaria infections) [16].

Rajcaniova et al. [23] estimate the long-run relationship between energy prices, bioenergy production, and the global land-use change. They find that rising energy (oil) prices and bioenergy production significantly contribute to the global land-use change both through the direct and indirect land-use change impact. The authors estimate the global agricultural area to increase yearly (in the period 1961–2009) by 35.6 million hectares due to the increasing oil price and by 12.1 million hectares due to increasing biofuel production. Diermeier and Schmidt [9] and Piroli et al. [22] also find that the crude oil price causes an increase in the area used for the production of maize, soybean oil, sugar, and wheat.

However, environmental externalities are just one part of the current public debate. The other issue is whether agricultural land and crops grown on it should be diverted to biofuels at the expense of food production. The oft-cited argument of biofuels opponents is that the additional demand for biofuel feedstocks (and land) creates upward pressure on food commodity markets, especially in periods when supply of grains and oilseeds is low (e.g., as it was the case with the 2012 drought in the United States).

A sharp rise in food commodity prices in 2008 has started a heated discussion on the contribution of biofuels to the price boom. Many studies have ascribed the commodity price rise to a "perfect storm" of factors (e.g., [1,18] arguing that it is impossible to apportion the role of biofuel policy on the price rise and volatility ex post [1]. But there are studies that find that biofuels increase food commodity prices.

A UN report of the Special Rapporteur on the right to food, Olivier De Schutter, finds that the rapid expansion of the demand for biofuels in rich countries results in higher food prices and speculation on farmland, and encourages land grabs on a large scale. The report suggests abandoning biofuel mandates and improving international cooperation to mitigate the impacts of increased levels of biofuel production on the prices of foodstuffs UN, 2014. A study by Hélaine et al. [19] focuses on the impact of EU biofuel policies on European commodity prices. They quantify the change in commodity prices resulting from abandoning the EU biofuel consumption targets in 2020. They find that compared to a business as usual scenario, most of the feedstock prices decline by 5 percent at most, with the exception of the EU price of vegetable oils which would decrease by 48 percent. The authors also simulate that with no biofuel policy in the European Union, almost 6 million hectares less cereals, oilseeds, sugar crops, and palm oil would be harvested globally.

Unlike the "perfect storm" studies, the literature represented by de Gorter et al. [7,8] argues that biofuel policies have a large impact on food grain commodity prices, first and foremost by linking biofuel prices to feedstock prices. The existence of such a link was confirmed theoretically by Cui et al. [5] and empirically tested by Mallory et al. [21]. This literature finds that in the new biofuel era biofuels and feedstock prices are directly and strongly linked (e.g., a $0.01-per gallon increase in ethanol prices results in corn prices increasing by $0.04 per bushel, meaning that the ethanol-corn multiplier is around four). de Gorter et al. [8] argue that most of the observed food commodity price increases of 2008 and 2011 were due to biofuel policies. Wright [28] also argues that biofuels are the solution to the puzzle of recent grain market behavior, and that the traditional market model, in addition to the substitution between grains as sources of calories, and substitution between successive harvests via storage, needs to be expanded to incorporate a third key substitution, that of biofuels for petroleum-based fuels.

On the other hand, Zilberman et al. [29] found that changes in biofuel prices have little impact on food prices. They argue that this result does not imply that the introduction of biofuels has minimal impacts on the price of food but that the analysis of the relationship between food and fuel prices cannot fully capture the impact of biofuel on food prices. Zilberman et al. [29] also found that the impact of the introduction of biofuels on food prices varies across crops and locations.

Not surprisingly, studies done by or for biofuel producers find none or very little effect of biofuels on food commodity prices. For example, Hamelinck [17] finds that the historic impact of EU biofuels demand until 2010 increased world grain (oilseeds) prices by about 1–2 (4) percent and, without any cap on crop-based biofuel production may lead to another 1 (10) percent increase through 2020. A review of the scholarly literature and the public debate, commissioned by the German Bioethanol Industry Association and carried out by von Witzke and Noleppa [27] finds that the impact of biofuels on prices and resource competition is rather limited and that scholarly research tends to yield much lower price increases and other related effects than those reported in various non-governmental organizations (NGO) publications, which is consistent with political economy theory.

4. Why the food versus fuel debate may be misleading in the European Union

The argument we want to make in this paper is that the debate about food versus fuel is often misleading. The reason for this is that many of the problems identified with food and bioenergy production in the European Union (on which we focus) have already been priced via several rules and regulations, including water use, fertilizer and pesticide use, protection of habitats, and sustainability of biofuels.

Consider Fig. 1, where the downward sloping curve MB denotes the marginal benefit of cultivating agricultural crops for human consumption and biofuel production. The marginal private and

[6] This figure does not include productive land currently covered by forests.

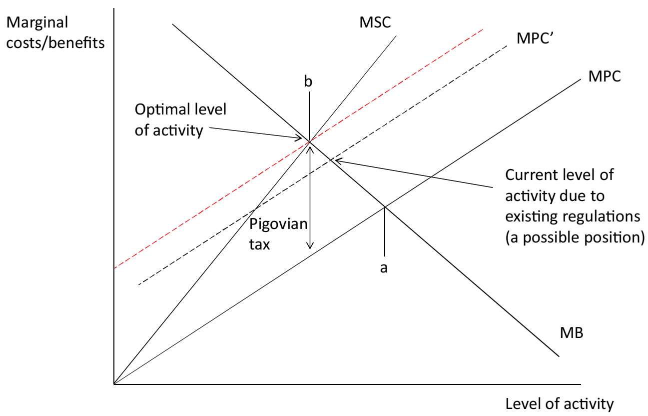

Fig. 1. Optimal level of agricultural activity and the effect of environmental regulations.

social costs of cultivation of crops are denoted by MPC and MSC, respectively. Suppose there are no environmental regulations in place in the European Union initially. In this situation, the EU crop production would correspond to point *a*, which is the intersection of the marginal benefit and marginal private cost curves. However, because of negative externalities associated with the agricultural activity, the socially optimal level of crop production is where the marginal benefit curve intersects with the marginal social cost curve—point *b* in Fig. 1. A possible solution how to achieve the socially optimal outcome would be to impose a Pigovian tax on crop production. The idea of a Pigovian tax is to increase the private marginal cost of crop production by the amount equal to the gap between the marginal social and private costs at the optimum. This means that when facing marginal costs that take into account the negative externalities of production, crop producers would produce at the socially optimal level (point *b*).

However, even in the absence of such a tax in reality all is not lost because the EU legislation does regulate the behavior of the agricultural sector through a number of regulations and directives (e.g., directives on Nitrate, Soil Erosion, Pesticide, Water Protection) that impose additional compliance costs on agricultural production, thus making agricultural producers partially internalize the negative externality. In Fig. 1, this is depicted by the curve MPC′ that is for illustrative purposes arbitrarily positioned below the MSC curve as its true position is not known.

Because land-based biofuels have been commercially produced for more than a decade and are expected to stay for at least some time, we do not attempt to answer the question whether biofuel production is optimal in the first place. Rather, we wish to focus on the implications of the concept outlined earlier for the food versus fuel debate. Our point is that when the environmental and other regulations are implemented and properly enforced, products produced at lower costs (including the environmental cost) require fewer resources and can be considered more environmentally friendly.

To illustrate this, consider the EU Fuel Quality Directive that stipulates minimum carbon savings for biofuels relative to fossil fuels. Such a regulation automatically alters the relative price of biofuels and fossil fuels. Thus the observed market prices of biofuels and agricultural commodities implicitly reflect additional costs related to various environmental and other regulations both in the European Union and worldwide. On the assumption that market participants behave rationally, the observed market prices stem from optimal participants' responses to a given institutional environment.

An observation that the area under crops used in the production of first-generation biofuels is growing, has been used as an argument against biofuels in the food versus fuel debate. It is because it suggests that the growing demand for biofuels drives conversion of additional land into agricultural use, thus leading to various negative externalities discussed earlier. Whereas this is a convincing argument, to be consistent, one should also consider what happens to the area of arable land under agricultural crops used for non-food production. Examples include the production of fiber crops such as seed cotton or sisal, or even the use of prime agricultural land for solar energy production covering the land with solar panels.

Fig. 2 depicts the development of world agricultural land areas under biofuel (the left-hand side axis) and non-biofuel feedstocks (the right-hand side axis). Biofuel feedstocks include wheat, maize, sugarcane, soybeans, and rapeseed and are used for both food and biofuel consumption (this partially explains the difference in the area compared to non-biofuel crops). Non-biofuel feedstocks in Fig. 2 include seed cotton, hempseed, and sisal. A key message of Fig. 2 is that the total area of the selected non-biofuel crops is weakly increasing (32.2 million hectares in 2000 and 37.3 million hectares in 2013), with a more significant rise after the year 2008, which marked the food commodity price crises. So if the critics of biofuels claim that biofuels take up additional areas of agricultural land at the expense of food production, then, to be consistent, they should also point to the expansion of, for example, seed cotton production.

Therefore, instead of discussing whether agricultural feedstock should be used in food or fuel production, we propose to compare production costs across products and countries to determine the resource efficiency. One implication of this for the European Union is that imports of biofuels/biofuels feedstocks from abroad might be beneficial.

To illustrate this point, in Table 1 we present a comparison of production costs per liter of ethanol and biodiesel produced from a variety of feedstocks in selected countries. Although the marginal production costs would be a more appropriate indicator of resource efficiency use, these costs are not readily available in the literature and would in any case be conditional on the level of production. The production costs in Table 1 are estimates based either on existing technological processes and observed feedstock prices or come from modeling exercises assuming future feedstock prices and technology used.

To show the implications for the European Union of different unitary costs of biofuel production worldwide, we compare the production cost of biodiesel from rapeseed oil in the European Union in 2015, €1.17–1.71 per liter, with the cost in the United States in 2014 of $0.898 per liter. The observed cost differential suggests that from the resource efficiency point of view[7] (and under the assumption that the transportation costs do not exceed that differential), it would be better if the European Union imported biodiesel from the United States (or other countries with lower production costs). This said, US biodiesel exporters face import tariffs on the EU market to this date (in part because of the EU retaliation for the US "splash & dash" program in 2009. See de Gorter et al. [6] for details).

A final implication of Table 1 is that importing (first-generation) biofuels from developing African countries such as Zambia, would not only be beneficial for the European Union from a resource allocation point of view (notice the significant cost differential), but might also stimulate development in rural areas of the developing countries and improve their foreign exchange balance.

[7] There are also other arguments for the EU biofuel policy and domestic biofuel production, for example, energy security that are not reflected in the resource efficiency argument. We thank an anonymous reviewer for pointing this out. It should also be stressed that environmental regulations and their market impacts are hard to compare internationally.

Fig. 2. Development of world agricultural land areas under biofuel and non-biofuel feedstocks.
Note: Biofuel feedstock = sum of wheat, maize, sugarcane, soybeans, and rapeseed; Non-biofuel feedstock = sum of seed cotton, sisal, and hempseed.
Source: Ref. [14].

Table 1
A comparison of biofuel production cost per liter.

Biofuel	Feedstock	Country	Year	Cost	Unit	Source
Ethanol	corn	EU	2015	1.06–1.40	€/liter	Festel et al. [12]
	wheat	EU	2015	1.36–1.86	€/liter	Festel et al. [12]
	waste	EU	2015	1.57–1.71	€/liter	Festel et al. [12]
	corn	USA	2010	0.467	$/liter	Derived from CARD [3]
	corn	USA	2013	0.577	$/liter	Derived from CARD [3]
	corn	USA	2014	0.445	$/liter	Derived from CARD [3]
	sugarcane	Zambia	2010	0.542	$/liter	Sinkala et al. [25]
	sweet sorghum	Zambia	2010	0.545	$/liter	Sinkala et al. [25]
Anhydrous ethanol	sugarcane	Brazil	2011–2012	0.738	$/liter	Shikida et al. [24]
Hydrous ethanol	sugarcane	Brazil	2011–2012	0.696	$/liter	Shikida et al. [24]
Biodiesel	rapeseed oil	EU	2015	1.17–1.71	€/liter	Festel et al. [12]
	waste oil	EU	2015	0.61–0.90	€/liter	Festel et al. [12]
	soybean oil	USA	2013	1.057	$/liter	Derived from CARD [4]
	soybean oil	USA	2014	0.898	$/liter	Derived from CARD [4]
	soybean oil	Zambia	2010	0.655	$/liter	Sinkala et al. [25]
	palm oil	Zambia	2010	0.612	$/liter	Sinkala et al. [25]
	jatropha	Zambia	2010	0.677	$/liter	Sinkala et al. [25]

5. Concluding remarks

The production and consumption of land-based biofuels has become an issue that has divided the public into proponents and opponents of these alternative energy sources. In this paper, we have taken a critical view of this public debate and its underlying arguments in the light of the existing environmental regulations in the European Union.

The key message of our paper is that the food versus fuel debate is often misleading in the EU context as many of the negative environmental externalities have very likely already been internalized as a result of existing environmental regulations. Therefore, instead of discussing whether agricultural crops should be used for food or fuel, we propose to compare production costs across products and countries to determine the resource efficiency.

Although the empirical estimates of production costs we have presented are only illustrative and conditional on various national and international policies (since the feedstock takes up a major part of the biofuel production cost) they still show there is room for consideration of reducing import tariffs for biofuels and biofuel feedstock coming to the European Union from countries exhibiting significantly lower biofuel production costs.

References

[1] P.C. Abbott, C. Hurt, W.E. Tyner, What's Driving Food Prices? Farm Foundation Issue Report, Farm Foundation, Oak Brook, IL, 2008.
[2] Alexandratos, N., Bruinsma, J., 2012. World Agriculture towards 2030/2050. The 2012 Revision. ESA Working Paper No. 12-03, June. http://www.fao.org/docrep/016/ap106e/ap106e.pdf.
[3] Center for Agricultural and Rural Development (CARD), 2015. Historical Ethanol Operating Margins. http://www.card.iastate.edu/research/bio/tools/hist_eth_gm.aspx.
[4] Center for Agricultural and Rural Development (CARD), 2015. Historical Ethanol Operating Margins. http://www.card.iastate.edu/research/bio/tools/hist_bio_gm.aspx.
[5] J. Cui, H. Lapan, G. Moschini, J. Cooper, Welfare impacts of alternative biofuel and energy policies, Am. J. Agric. Econ. 93 (5) (2011) 1235–1256.
[6] H. de Gorter, D. Drabik, D.R. Just, The economics of a blender's tax credit versus a tax exemption: the case of U.S. 'Splash and Dash' biodiesel exports to the European Union, Appl. Econ. Perspect. Policy 33 (4) (2011) 510–527.
[7] H. de Gorter, D. Drabik, D.R. Just, Biofuel policies and food grain commodity prices 2006–2012: all boom and no bust? AgBioForum 16 (1) (2013) 1–13.
[8] H. de Gorter, D. Drabik, D.R. Just, The Economics of Biofuel Policies: Impacts On Price Volatility in Grain and Oilseed Markets, Palgrave Macmillan, 2015 (316 pages. Palgrave Studies in Agricultural Economics and Food Policy).
[9] M. Diermeier, T. Schmidt, Oil price effects on land use competition: an empirical analysis, Agric. Econ. Rev. 15 (1) (2014) 98–114.
[11] European Parliament, 2013. European Parliament Backs Switchover to Advanced Biofuels. http://www.europarl.europa.eu/news/en/news-room/content/20130906IPR18831/html/European-Parliament-backs-switchover-to-advanced-biofuels.
[12] Festel G., Würmseher M., Rammer C., Boles E., Bellof, M., 2013. Modelling, Production Cost Scenarios for Biofuels and Fossil Fuels in Europe. Centre for European Economic Research Discussion Paper No. 13-075. http://ftp.zew.de/pub/zew-docs/dp/dp13075.pdf.
[14] Food and Agriculture Organization of the United Nations, Statistics Division (FAOSTAT), 2015. http://faostat3.fao.org/download/Q/QC/E.
[15] S. Fritz, L. See, M. van der Velde, R.A. Nalepa, C. Perger, C. Schill, I. McCallum, D. Schepaschenko, F. Kraxner, X. Cai, X. Zhang, S. Ortner, R. Hazarika, A. Cipriani, C. Di Bella, A.H. Rabia, A. Garcia, M. Vakolyuk, K. Singha, M.E. Beget, S. Erasmi, F. Albrecht, B. Shaw, M. Obersteiner, AT downgrading recent estimates of land available for biofuel production, Environ. Sci. Technol. 47 (3) (2013) 1688–1694.
[16] Garg, T., 2014. Public Health Effects of Natural Resource Degradation: Evidence from Deforestation in Indonesia. A paper presented at Agricultural and Applied Economics Association 2014 Annual Meeting, July 27–29, Minneapolis, Minnesota. http://purl.umn.edu/169822.
[17] Hamelinck, 2013. Biofuels and Food Security: Risks and Opportunities. A study done by ePURE. http://www.ecofys.com/files/files/ecofys-2013-biofuels-and-food-security.pdf.
[18] D. Headey, S. Fan, Reflections on the Global Food Crisis: How It Happened? How It Hurt? And, How We Can Prevent the Next One? Research Monograph 165, International Food Policy Research Institute, Washington, DC, 2010.
[19] Hélaine, S., M'barek, R., Gay, H., 2013. Impacts of the EU Biofuel Policy on Agricultural. Markets and Land Use: Modelling Assessment with AGLINK-COSIMO. JRC scientific and policy report EUR 26107 EN. http://ftp.jrc.es/EURdoc/JRC83936.pdf.
[21] M.L. Mallory, S.H. Irwin, D.J. Hayes, How market efficiency and the theory of storage link corn and ethanol markets, Energy Econ. 34 (6) (2012) 2157–2166.
[22] G. Piroli, P. Ciaian, D. Kancs, Land use change impacts of biofuels: near-VAR: evidence from the US, Ecol. Econ. 84 (2012) 98–109.
[23] M. Rajcaniova, D. Kancs, P. Ciaian, Bioenergy and global land-use change, Appl. Econ. 46 (26) (2014) 3163–3179.
[24] P.F.A. Shikida, A. Finco, B.F. Cardoso, V.A. Galante, D. Rahmeier, D. Bentivoglio, M. Rasetti, A comparison between ethanol and biodiesel production: the brazilian and european experiences, in: A. Domingos Padula, et al. (Eds.), Liquid Biofuels: Emergence, Development and Prospects, Lecture Notes in Energy 27, Springer-Verlag, London, 2014.
[25] Sinkala, T., Timilsina, G.R., Ekanayake, I.J., 2013. Are Biofuels Economically. Competitive with Their Petroleum Counterparts? Production Cost Analysis for Zambia. Policy Research Working Paper 6499, June. elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-6499.
[27] von Witzke, H., Noleppa, S., 2014. Biofuels: Agricultural Commodity Prices, Food Security, and Resource Use. A Review of the Scholarly Literature and the Public Debate. Agripol research paper 2014-02. http://www.agripol-network.com/wp-content/uploads/2014/07/agripol_rp022014_2014.pdf.
[28] Brian Wright, Global biofuels: key to the puzzle of grain market behavior, J. Econ. Perspect. 28 (1) (2014) 73–98.
[29] D. Zilberman, G. Hochman, D. Rajagopal, S. Sexton, G. Timilsina, The impact of biofuels on commodity food prices: assessment of findings, Am. J. Agric. Econ. 95 (2) (2013) 275–281.