ANNEX C

Impact of the Energy Independence Security Act on Biofuels and Crop Markets: Aglink Analysis

C.1. Background

An argument exists that government biofuel consumption or production mandates create indirect support to the agricultural feedstocks used to produce these biofuels because they elevate demand, thereby increasing not only the feedstock prices, but other commodity prices as well. The Energy Independence Security Act (EISA) of 2007 brought significant increases to the biofuel consumption mandates for the United States. Previously, under the Energy Policy Act (EPAct) of 2005, the aim had been to reach 7.5 billion gallons by 2012.

EISA increased this level to 36 billion gallons by 2022. The ethanol consumption mandates of the United States have led to large increases in the production of maize-based ethanol and have contributed to elevating maize prices to a new, higher price plateau. However, in the United States total ethanol demand is mostly influenced by the following three factors: government consumption mandates, oxygenate demand, and finally demand from consumers or blenders. This consumer market demand is heavily influenced by the relative price ratio of gas *versus* ethanol and, possibly, a consumer preference to use a fuel that is more "environmentally friendly". It should be noted that oxygenate and consumer market demand can both contribute to the total government consumption mandate.

To determine what effect the EISA biofuels consumption mandates are having on crop markets, especially maize, it is proposed in this analysis to re-set the levels back to those originally proposed under the EPAct of 2005. This analysis will show the potential impact of the different consumption mandates if the government consumption mandates were determining total ethanol demand. However, before the EPAct and during its enforcement, total US ethanol consumption had surpassed both oxygenate and government mandates by an average of 38%. To reflect that "consumer market demand" could have continued to increase ethanol consumption above EPAct mandates it is proposed to follow an analogous procedure as that used by the Environmental Protection Agency (EPA) in their Final Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis (RIA). More specifically, the difference between EISA and an adjusted consumption of ethanol at 38% higher than the level mandated under EPAct is analysed, hereafter referred to as "EPAct plus".[1]

Although it is unclear whether this higher "consumer market demand" would have been sustained in the future, considering that during the time that EPAct was in force a period of escalating oil and gas prices occurred, which caused gasoline blenders to look to secure ethanol supplies to meet oxygenate requirements; there was also speculation at that time that a new biofuels policy (*i.e.* EISA) would require substantially more biofuels consumption. All of these factors probably inflated the "consumer market demand" at that period and it is difficult to determine what the long-term equilibrium consumption level would have been. The story for biodiesel is different because it seems that in almost all years US consumption would have been lower than the blending mandate and therefore, a scenario with increased "consumer demand" for biodiesel is not undertaken.

The AGLINK-COSIMO model, along with OECD-FAO *2010 Outlook*, which serves as the baseline, is used to determine the impacts on biofuels and crop markets (OECD-FAO, 2010). Obviously, considering that EISA was signed into law on 19 December 2007, its impacts have already been reflected in both crop and biofuel markets. The OECD-FAO *Outlook* only provides a projection from 2010 to 2019, so this analysis simply notes the percentage changes in markets as a result of reducing the biofuel consumption mandates to the levels specified by the EPA of 2005 or to the increased consumption levels implied by "EAct plus". For the most part, this analysis and discussion focus on the difference between government blending mandates of EPAct *versus* EISA. The results could potentially indicate the relative price impacts of the two different government blending mandates of EPAct 2005 and EISA 2007, but should not be taken to be the absolute impact of EISA on US biofuel and crop markets. The discussion will bring in results from the "EPAct plus", when referring to ethanol consumption levels and crop price impacts, to show relative impacts if consumer market demand for ethanol would have been at a sustained, elevated level above the EPAct levels.

EPAct was less comprehensive than EISA, in that there was no advanced biofuel mandate and no requirements to reduce greenhouse gas emissions. However, the "RFS case" scenario of EPA made assumptions on the specific amounts of biofuels from feedstock. Although the policy required production of 7.5 billion gallons of biofuels, the EPA had determined in their "RFS case" scenario that biodiesel and cellulosic[2] ethanol should be attributed higher net energy equivalence, which then reduced the required volume to 6.97 billion gallons.[3] The amounts in Tables C.1 and C.2 outline EPAct 2005 biofuel consumption assumptions and EISA biofuel consumption mandates. To determine the growth paths for each biofuel, the proportions of each to the total energy equivalent RFS in 2012 were held constant for each year and then extrapolated backwards.

Table C.1. **EPAct 2005 renewable fuel standard**

	2005 RFS timeline (billion gallons)				
	Total RFS volume	Total energy equivalent	Maize	Cellulosic	Biodiesel
2006	4	4	4		
2007	4.7	4.370	4.024	0.157	0.190
2008	5.4	5.021	4.623	0.180	0.218
2009	6.1	5.672	5.222	0.203	0.246
2010	6.8	6.323	5.822	0.227	0.275
2011	7.4	6.881	6.335	0.247	0.299
2012	7.5	6.974	6.421	0.250	0.303

Note: The sum of cellulosic, biodiesel and maize does not equal 7.5 because it is not expressed in net energy equivalence.

Table C.2. **EISA renewable fuel standard**

	EISA RFS timeline (billion gallons)				
	Cellulosic	Biomass-based diesel	Total advanced	Potential maize based	Total RFS
2008	n.a.	n.a.	n.a.	9.0	9.0
2009	n.a.	0.5	0.6	10.5	11.1
2010	0.1	0.65	0.95	12	12.95
2011	0.25	0.8	1.35	12.6	13.95
2012	0.5	1	2	13.2	15.2
2013	1	1	2.75	13.8	16.55
2014	1.75	1	3.75	14.4	18.15
2015	3	1	5.5	15	20.5
2016	4.25	1	7.25	15	22.25
2017	5.5	1	9	15	24
2018	7	1	11	15	26
2019	8.5	1	13	15	28
2020	10.5	1	15	15	30
2021	13.5	1	18	15	33
2022	16	1	21	15	36

Note: Total advanced includes net energy equivalence.

As can be seen in comparing Tables C.1 and C.2, the EPAct mandates require significantly lower biofuel quantities compared to the current EISA policy. However, even though EPA assumed in their reference scenario that cellulosic ethanol consumption under EPAct would reach 250 million gallons by 2012, it is unclear whether this target would have been met, considering that currently there is very limited cellulosic ethanol production, and the current baseline indicates that this level of consumption will not be realised until 2014. In addition, EPAct gave a higher ethanol tax credit of USD 0.51 per gallon, *versus* the current tax credit of USD 0.45 per gallon, and the tax credit was set back to the EPAct level for the scenario analysis.

For the scenario analysis, it was assumed that cellulosic production and consumption would equal what was already present in the baseline. EPAct required that once the total RFS was achieved, the biofuel consumption percentage would have to be maintained in proportion to total fuel consumption – it is for this reason that biofuel consumption grows past 2012 in the scenario. The following table shows the EPAct biofuel consumption assumptions that were used in the analysis. For the "EPAct plus" scenario maize-based ethanol consumption levels were increased by 38% above the levels shown below and cellulosic-based ethanol consumption remained unchanged considering the challenges of meeting the EPAct base level mandates.

C.2. Biofuel production

For maize ethanol production, the capacity is determined endogenously with the previous year's capacity used as a starting point and it then grows (given relative returns to maize ethanol production) from 2010 to 2019. For 2010, the previous year's capacity was the 2009 EPAct maize ethanol consumption level. Under this scenario, maize ethanol production in 2010 would have reached only 24.3 million litres, instead of the 45.4 million litres projected in the baseline, which is a decrease of 21.1 million and represents a 46.5% reduction. Figure C.1 shows the reduction in maize-based ethanol production in the scenario compared to the baseline.

Table C.3. **EPAct 2005 renewable fuel standard projection assumptions**

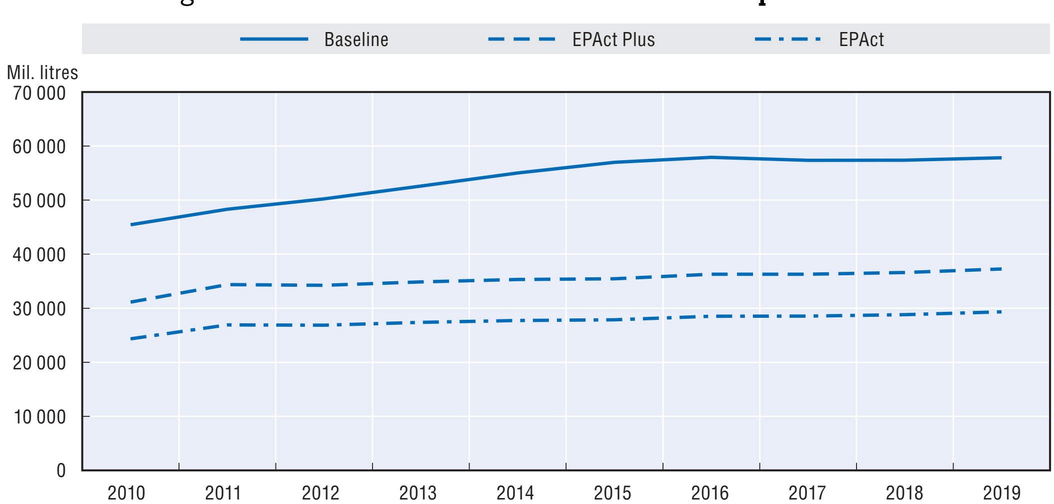
EPA of 2005 RFS	Million litres				
Year	2010	2011	2012	2013	2014
Maize-based ethanol	22 038	23 982	24 306	24 576	24 840
Cellulosic ethanol	858	934	946	957	967
Biodiesel	1 040	1 132	1 147	1 160	1 172
RFS total volume	25 177	27 164	27 183	27 032	26 979
RFS total NET NRG	25 743	28 014	28 392	28 707	29 016
RFS total NET NRG (mil. gallons)	6 800	7 400	7 501	7 584	7 665
EPA of 2005 RFS	Million litres				
Year	2015	2016	2017	2018	2019
Maize-based ethanol	25 093	25 337	25 567	25 784	25 990
Cellulosic ethanol	977	986	995	1 004	1 012
Biodiesel	1 184	1 196	1 206	1 217	1 226
RFS total volume	27 254	27 519	27 769	28 005	28 229
RFS total NET NRG	29 312	29 596	29 865	30 119	30 360
RFS total NET NRG (mill. gallons)	7 743	7 818	7 890	7 957	8 020

Note: RFS NET NRG refers to the RFS net energy equivalence.

Overall, the average reduction in maize ethanol production was 48.6% over 2010-19. However, it should be noted that when the Environmental Protection Agency issued the final rule in 2007, it used a projection from the Energy Information Administration which projected that by 2012 maize-based ethanol consumption would surpass its mandate and reach 9.388 billion gallons. For the "EPAct plus" scenario the reduction in maize-based ethanol production was on average 34.5% from 2010 to 2019 and the production difference in 2010 was approximately 14.3 million litres or 31.5%.

Likewise, for biodiesel production the capacity is determined endogenously with the previous year's capacity used as a starting point and it then grows (given relative returns to biodiesel production) from 2010 to 2019. In 2010, biodiesel production decreases by

Figure C.1. **Reduction in maize-based ethanol production**

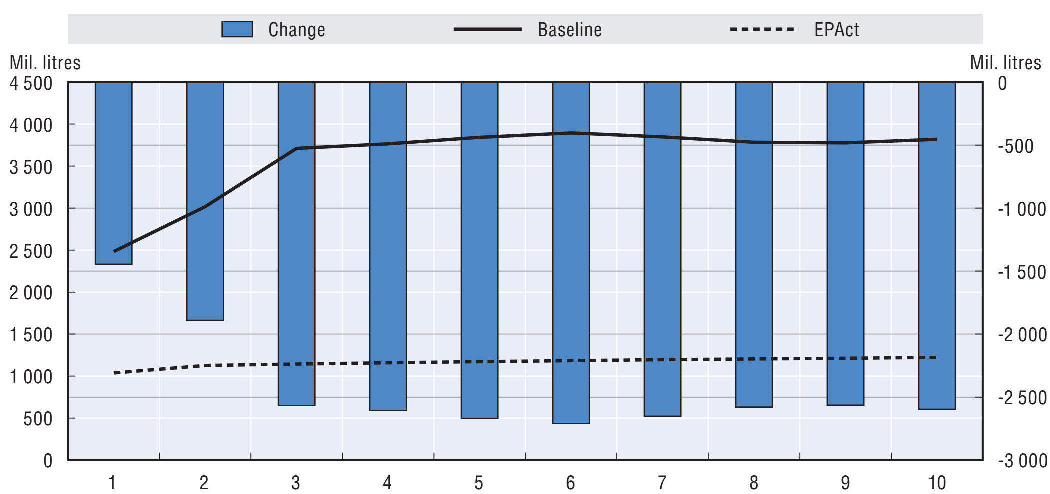


1.4 million litres and by 2019 there is a decrease of 2.6 million litres, which, on average, represents a 67% reduction from 2010-19.

Considering that biodiesel can be produced from either vegetable oil or tallow, in the scenario it was assumed that the proportions of each respective feedstock used in biodiesel production would be equal to the proportions in the baseline and, therefore, their respective percentage decreases are equal to the percentage decrease in biodiesel production.

In 2010, vegetable oil use for biodiesel decreases by 503 000 tonnes and by 2019 the reduction amounts to 744 000 tonnes. Although this represents a significant decrease in vegetable oil use for biodiesel, it is relatively small when compared to total consumption of vegetable oil – 12 645 000 tonnes in 2019. Figure C.2 shows the reduction in biodiesel production in the scenario compared to the baseline.

Figure C.2. **EPAct reduction in biodiesel production**



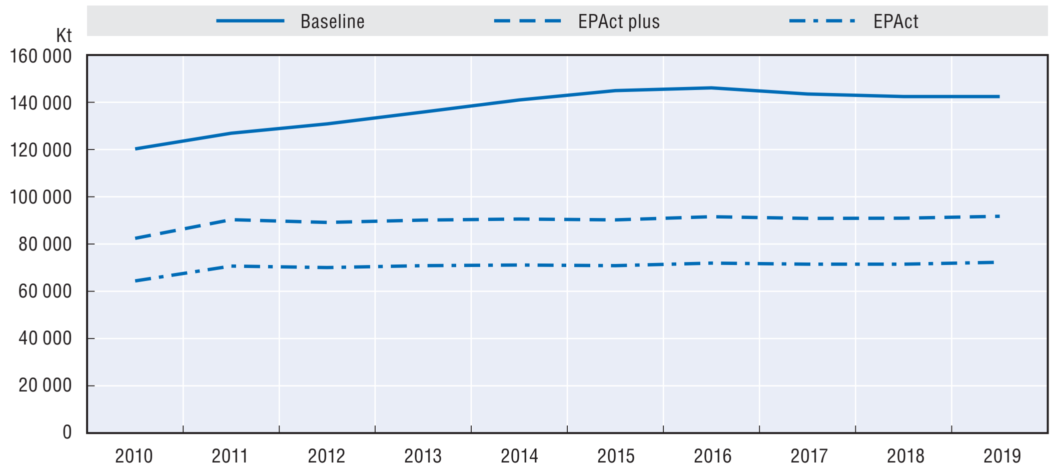
C.3. The maize market

The reduction in maize-based ethanol production directly reduces the use of maize for ethanol and causes a significant decrease in demand for maize. In 2010, this amount translates to a 55.8 million tonne reduction, and by 2019 this amount increases to 66.9 million tonnes (Figure C.3). Obviously, this puts downward pressure on US maize prices and there is a significant decrease in maize prices.

As shown in Figure C.4, the largest decrease is in 2010, with a price decrease of 16% because in the baseline the level of maize ethanol production is significantly larger than the implied EPAct mandate for 2010; as explained above, EISA and high oil prices had already encouraged production well above EPAct levels.

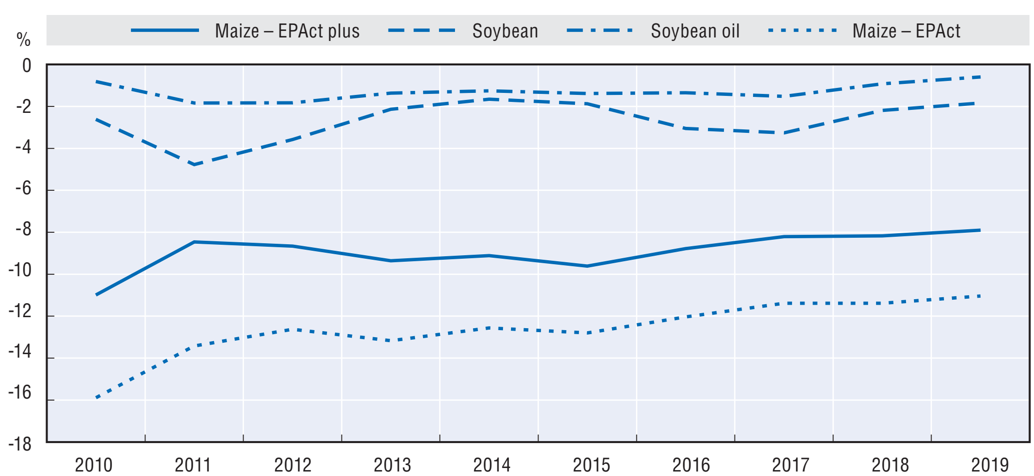
The decrease in maize prices then approaches the –13% range by 2012 and then hovers slightly below this until 2015. In the baseline, maize ethanol production growth levels off in 2015 and only grows at the rate of fuel consumption after 2015. There is a slight dip in maize prices in 2015 because this is where there is the smallest increase in the baseline for maize ethanol consumption. Thereafter, the price decrease is close to –11% as market approach a long-term equilibrium.

Figure C.3. **Reduction in ethanol-maize use**



Overall, maize prices are on average 13% lower throughout 2010-19 with the EPAct biofuel consumption assumptions. One might have expected larger price impacts for maize, but it has to be remembered that with less maize ethanol production, there will be less dried distilled grains available for feed. The average reduction in the production of maize-based dried distilled grains was 21.9 million tonnes, which ultimately lead to an increase in coarse grain feed consumption of 15.2 million tonnes.[4] The increased demand for coarse grains for feed helps alleviate some of the downward pressure on maize prices. For the "EPAct plus" scenario the average reduction in maize prices was –9% compared to the EPAct of –13%.

Figure C.4. **Percentage reduction in US maize, soybean and soybean oil prices**



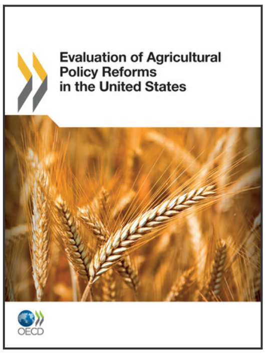
The decrease in maize prices, along with the decrease in soybean oil prices, resulting from lower biodiesel demand for vegetable oil, both contribute to a decrease in soybean prices. On average, from 2010 to 2019 soybean oil prices are only 1% lower and soybean prices are on average 3% lower. The price effects are more adverse for maize because the share of maize going to ethanol production is higher than the share of soybean oil going to biodiesel production. Biodiesel production also uses non-crop feedstocks such as tallow. The price impacts for soybeans and soybean oil under "EPAct plus" were almost exactly the same as EPAct considering no change at the consumption of biodiesel was required.

The purpose of this scenario was to analyse to what extent new EISA biofuel consumption mandates were affecting biofuel and crop markets, specifically maize. It can be seen that EISA substantially increased the amount of biofuels needed to meet the renewable fuel standard, as in 2012 it went from 7.5 billion gallons (under EPAct) to 15.2 billion gallons. Although EISA only permits 15 billion gallons of maize ethanol consumption to be eligible for the RFS 2015, represent 73% of the RFS mandate that year. It is not until 2020 that the advanced biofuel consumption mandate equals the 15-billion gallon maximum maize-based ethanol consumption that can be counted toward the overall RFS.

EPAct would have required substantially less maize-based ethanol production and, consequentially, lower maize use for ethanol, which would have impacted maize prices. Lowering the consumption mandates to the EPA levels results in maize, soybean and soybean oil prices that are on average –13%, –3% and –1%, respectively, lower than those in the baseline under EISA. However, if consumer or blenders' demand for ethanol were to have been sustained above EPAct blending levels, as seen prior to EISA, then ethanol consumption would have been higher and the maize price impacts would have been approximately only –9% lower. It is, however, uncertain as to whether consumer market demand would have been sustained in the long-term at those levels above government blending mandates. Overall, this analysis exhibits how biofuel policies can indirectly influence the prices for feedstocks used to produce biofuels by increasing their respective demand.

Notes

1. Total historical US ethanol consumption from 2004 to 2007 was compared to oxygenate and government blending mandates to determine the excess "consumer market demand", which was found to be on average 38% higher during those four years. EPA's assessment of the final rule stated a base scenario in 2004 and it projected that by 2012 there would be approximately a 42.5% increase in ethanol consumption above the EPAct blending mandate, but at that time they probably had a different macro-economic projection without the 2009 financial crisis and subsequent recession.
2. Although the Environmental Protection Agency gave cellulosic ethanol an energy equivalence of 2.5 this was changed under EISA, whereby all denatured ethanol is considered to have an energy equivalence of only 1, regardless of the feedstock used to produce it.
3. This total volume requirement for the "RFS case" scenario was taken from the US EPA (2007).
4. The AGLINK-COSIMO modelling framework assumes that one tonne of DDG replaces 0.94 tonne of coarse grains in ruminant feed ratio and 0.7 tonne of coarse grains in non-ruminant feed ratio.



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