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ENVIRONMENTAL PROTECTION AGENCY 6560-50-P

[EPA-HQ-OAR-2016-0771; FRL-9958-88-OAR]

Notice of Opportunity to Comment on an Analysis of the Greenhouse Gas Emissions Attributable to Production and Transport of *Beta vulgaris ssp. vulgaris* (Sugar Beets) for Use in Biofuel Production

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: In this notice, the Environmental Protection Agency (EPA) is inviting comment on its analysis of the upstream greenhouse gas emissions attributable to the production of *Beta vulgaris ssp. vulgaris* (sugar beets) for use as a biofuel feedstock. This notice describes EPA's greenhouse gas analysis of sugar beets produced for use as a biofuel feedstock, and describes how EPA may apply this analysis in the future to determine whether biofuels produced from sugar beets meet the necessary greenhouse gas reduction threshold required for qualification as renewable fuel under the Renewable Fuel Standard program. This notice considers a scenario in which non-cellulosic beet sugar is extracted for conversion to biofuel and the remaining beet pulp co-product is used as animal feed. Based on this analysis, we anticipate that biofuels produced from sugar beets could qualify as renewable fuel or advanced biofuel, depending on the type and efficiency of the fuel production process technology used.

DATES: Comments must be received on or before **[INSERT DATE 30 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER]**.

ADDRESSES: Submit your comments, identified by Docket ID No. EPA-HQ-OAR-2016-0771, at http://www.regulations.gov. Follow the online instructions for submitting comments. Once submitted, comments cannot be edited or withdrawn from Regulations.gov. The EPA may publish any comment received to its public docket. Do not submit electronically any information you consider to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Multimedia submissions (audio, video, etc.) must be accompanied by a written comment. The written comment is considered the official comment and should include discussion of all points you wish to make. The EPA will generally not consider comments or comment contents located outside of the primary submission (i.e., on the web, cloud, or other file sharing system). For additional submission methods, the full EPA public comment policy, information about CBI or multimedia submissions, and general guidance on making effective comments, please visit https://www.epa.gov/dockets/commenting-epa-dockets.

FOR FURTHER INFORMATION, CONTACT: Christopher Ramig, Office of Air and Radiation, Office of Transportation and Air Quality, Mail Code: 6401A, U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue, NW, Washington, DC 20460; telephone number: 202-564-1372; fax number: 202-564-1177; email address: ramig.christopher@epa.gov.

SUPPLEMENTARY INFORMATION:

This notice is organized as follows:

I. Introduction

Section 211(o) of the Clean Air Act establishes the renewable fuel standard ("RFS") program, under which EPA sets annual percentage standards specifying the amount of renewable fuel, as well as three subcategories of renewable fuel, that must be used to reduce or replace fossil fuel present in transportation fuel, heating oil or jet fuel. With limited exceptions, renewable fuel produced at facilities that commenced construction after enactment of the Energy Independence and Security Act of 2007 ("EISA"), must achieve at least a twenty percent reduction in lifecycle greenhouse gas emissions as compared to baseline 2005 transportation fuel. Advanced biofuel and biomass-based diesel must achieve at least a fifty percent reduction, and cellulosic biofuel must achieve at least a sixty percent reduction.

As part of changes to the RFS program regulations published on March 26, 2010[1] (the "March 2010 RFS rule") to implement EISA amendments to the RFS program, EPA identified a number of renewable fuel production pathways that satisfy the greenhouse gas reduction requirements of the Act. Table 1 to 40 CFR 80.1426 of the RFS regulations lists three critical components of approved fuel pathways: (1) fuel type; (2) feedstock; and (3) production process. In addition, for each pathway, the regulations specify a "D code" that indicates whether fuel

[1] See 75 FR 14670

produced by the specified pathway meets the requirements for renewable fuel or one of the three renewable fuel subcategories. EPA may independently approve additional fuel pathways not currently listed in Table 1 to 40 CFR 80.1426 for participation in the RFS program, or a party may petition for EPA to evaluate a new fuel pathway in accordance with 40 CFR 80.1416. Pursuant to 40 CFR 80.1416, EPA received petitions from Green Vision Group, Tracy Renewable Energy, and Plant Sensory Systems, submitted under partial claims of confidential business information (CBI), requesting that EPA evaluate the GHG emissions associated with biofuels produced using sugar beets as feedstock, and that EPA provide a determination of the renewable fuel categories, if any, for which such biofuels may be eligible.

EPA's lifecycle analyses are used to assess the overall GHG impacts of a fuel throughout each stage of its production and use. The results of these analyses, considering uncertainty and the weight of available evidence, are used to determine whether a fuel meets the necessary GHG reductions required under the CAA for it to be considered renewable fuel or one of the subsets of renewable fuel. Lifecycle analysis includes an assessment of emissions related to the full fuel lifecycle, including feedstock production, feedstock transportation, fuel production, fuel transportation and distribution, and tailpipe emissions. Per the CAA definition of lifecycle GHG emissions, EPA's lifecycle analyses also include an assessment of significant indirect emissions, such as indirect emissions from land use changes and agricultural sector impacts.

This document describes EPA's analysis of the GHG emissions from feedstock production and feedstock transport associated with sugar beets when used to produce biofuel, including significant indirect impacts. This notice considers a scenario in which non-cellulosic beet sugar (primarily sucrose, glucose and/or fructose) is extracted for conversion to biofuel and the remaining beet pulp co-product is used as animal feed. As will be described in Section II, we estimate the GHG emissions associated with production and transport of sugar beets for use as a biofuel feedstock are approximately 45 kilograms of CO_2-equivalent per wet short ton (kgCO_2e per wet short ton) of sugar beets.[2] Based on these results, we believe biofuels produced from sugar beets through recognized conversion processes could qualify as advanced biofuel and/or conventional (non-advanced) renewable fuel, depending on the type and efficiency of the fuel production process technology used. EPA is seeking public comment on its analysis of greenhouse gas emissions related to sugar beet feedstock production and transport.

If appropriate, EPA will update this analysis based on comments received in response to this notice. EPA will use this updated analysis as part of the evaluation of facility-specific petitions received pursuant to 40 CFR 80.1416 that propose to use sugar beets as a feedstock for the production of biofuel.[3] Based on this information, EPA will determine the GHG emissions associated with petitioners' biofuel production processes, as well as emissions associated with the transport and use of the finished biofuel. EPA will combine these assessments into a full lifecycle GHG analysis used to determine whether the fuel produced at an individual facility

[2] For purposes of this notice, we assume that sugar beets have an average moisture content of 76%. See Food and Agriculture Organization, 1999, "Agribusiness Handbooks Vol. 4 Sugar Beets/White Sugar", http://www.responsibleagroinvestment.org/sites/responsibleagroinvestment.org/files/FAO_Agbiz%20handbook_White%20Sugar_0.pdf (Last Accessed: January 4, 2017).

[3] Assuming the fuel pathway proposed in such petitions involve extraction of non-cellulosic beet sugar for conversion to biofuel and use of the resulting beet pulp co-product as animal feed.

satisfies the CAA GHG emission reduction requirements necessary to qualify as renewable fuel or one of the subcategories of renewable fuel under the RFS program.

II. Analysis of GHG Emissions Associated with Production and Transport of Sugar Beets for Use as a Biofuel Feedstock

A. *Overview of Beta vulgaris ssp. vulgaris (Sugar Beets)*

Beta vulgaris ssp. vulgaris, (commonly known as sugar beets) of the order *Caryophylalles,* is a widely cultivated plant of the Altissima group. Sugar beets are cultivated for their high percentage concentration of sucrose in their root mass. Domestication of the plant group took place approximately 200 years ago in Europe to selectively breed for sugar content from crosses between *Beta vulgaris* cultivars, including chard plants and fodder beets.[4]

Sugar beets are a biennial crop species grown across a wide tolerance of soil conditions in areas of temperate climate, and tend to be grown in rotation with other plant varieties.[5] Sugar beets are grown for their relatively high sugar content, approximately 13 to 18 percent of the plant's total mass, with around three quarters of the plant mass comprised of water.[6] Once

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[4] Juliane C. Dohm et al., "The Genome of the Recently Domesticated Crop Plant Sugar Beet (Beta Vulgaris)," *Nature* 505, no. 7484 (January 23, 2014): 546–49.
[5] Michael J. McConnell, "USDA ERS - Background," *Crops Sugar & Sweeteners Background*, October 12, 2016, http://www.ers.usda.gov/topics/crops/sugar-sweeteners/background/.
[6] FAO, "Sugar Crops and Sweeteners and Derived Products," accessed November 30, 2016, http://www.fao.org/es/faodef/fdef03e.HTM.

harvested, sugar beets are highly perishable and need to be processed in a short period of time.[7]

According to the U.S. Department of Agriculture (USDA), the largest region for sugar beet production is the area of the Red River Valley of western Minnesota and eastern North Dakota, and sugar beets are commonly grown at agricultural scale across five regions of the country, encompassing 11 states.[8] Western regions tend to require more irrigation while sugar beets grown in the eastern U.S. region make greater use of natural rainfall.[9]

Since the mid-1990s, sugar beets have accounted for about 55 percent of sugar production in the U.S.[10] Sugar beets are included in the U.S. sugar program, designed to support domestic sugar prices through loans to sugar processors. The U.S. sugar program also includes a marketing allotment that sets the amount of sugar that domestic processors can sell in the U.S. for human consumption, and provides quotas on the amount of sugar that can be imported into the U.S.[11] Sugar produced under the program cannot be used for biofuel purposes with an exception for surplus sugar made available under the USDA Feedstock Flexibility Program that specifically directs the excess sugar to be used for the purpose of domestic biofuel production.[12]

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[7] Michael J. McConnell, "USDA ERS - Policy," *USDA ERS - Policy*, November 1, 2016, https://www.ers.usda.gov/topics/crops/sugar-sweeteners/policy.aspx.
[8] Michael J. McConnell, "USDA ERS - Background."
[9] Michael J. McConnell, "USDA ERS - Background."
[10] Michael J. McConnell, "USDA ERS - Background."
[11] The U.S. sugar program is managed by USDA and supports domestic sugar prices through loans to sugar processors, a marketing allotment program, and quotas on the amount of sugar that can be imported to the U.S. Farm Security and Rural Investment Act of 2002. P.L. 107-171, Sec. 1401-1403.
[12] "Feedstock Flexibility Program," page, accessed November 17, 2016, https://www.fsa.usda.gov/programs-and-services/energy-programs/feedstock-flexibility/index.

Like other sugars, beet sugar can be fermented and used as a feedstock for biofuel production. The non-cellulosic sugars of sugar beets, the vast majority of which is sucrose, can be converted directly into a refined sugar available for processes such as alcoholic fermentation to produce biofuels (e.g., ethanol).[13] Much of the water needed for the fermentation process is provided by the sugar beets themselves. Sugar beet pulp is a fibrous co-product of the beet sugar extraction process.[14] The sugar beet pulp is often dried to reduce transportation costs and is widely sold as feed supplement for cattle and other livestock.[15] While biofuel production from beet sugar has historically been limited in the U.S., sugar beets accounted for about 17 percent of European ethanol production in 2014.[16]

B. <u>Analysis of Upstream GHG Emissions</u>

EPA evaluated the upstream GHG emissions associated with using sugar beets as a biofuel feedstock based on information provided by USDA, petitioners, and other data sources. Upstream GHG emissions include emissions from production and transport of sugar beets used as a biofuel feedstock. The methodology EPA used for this analysis is generally the same approach used for the March 2010 RFS rule for lifecycle analyses of several other biofuel

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[13] Dr. Hossein Shapouri, Dr. Michael Salassi, and J. Nelson Fairbanks, "The Economic Feasibility of Ethanol Production from Sugar in the United States" (USDA, July 2006), http://www.usda.gov/oce/reports/energy/EthanolSugarFeasibilityReport3.pdf.

[14] Eggleston, Gillian et al., "Ethanol from Sugar Crops." In, Singh, Bharat P., *Industrial Crops and* Uses. CABI, 2010, pp. 74-75.

[15] Greg Lardy, "Feeding Sugar Beet Byproducts to Cattle," accessed November 30, 2016, https://www.ag.ndsu.edu/publications/livestock/feeding-sugar-beet-byproducts-to-cattle.

[16] ePURE, "European Renewable Ethanol – Key Figures," accessed November 17, 2016, http://epure.org/media/1227/european-renewable-ethanol-statistics-2015.pdf.

feedstocks, such as corn, soybean oil, and sugarcane.[17] The subsections below describe this methodology, including assumptions and results of our analysis.

1. Methodology and Scenarios Evaluated

The analysis EPA prepared for sugar beets used the same set of models that were used for the March 2010 RFS rule, including the Forestry and Agricultural Sector Optimization Model (FASOM) developed by Texas A&M University for domestic impacts, and the Food and Agricultural Policy and Research Institute international models as maintained by the Center for Agricultural and Rural Development (FAPRI–CARD) at Iowa State University for international impacts. For more information on the FASOM and FAPRI–CARD models, refer to the March 2010 RFS rule preamble (75 FR 14670) and Regulatory Impact Analysis (RIA).[18] Several modifications were made to the domestic and international agricultural economic modeling that differed from previous analyses in order to accurately represent the U.S. sugar program.[19] Memoranda to the docket include detailed information on model inputs, assumptions, calculations, and the results of our assessment of the upstream GHG emissions for sugar beet biofuels.[20] We invite comments on the scenarios and assumptions used for this analysis, in particular on the key assumptions described in this section.

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[17] The March 2010 RFS rule preamble (75 FR 14670, March 26, 2010) and Regulatory Impact Analysis (RIA) (EPA-420-R-10-006) provide further discussion of our approach. These documents are available online at https://www.epa.gov/renewable-fuel-standard-program/renewable-fuel-standard-rfs2-final-rule-additional-resources.

[18] The March 2010 RFS rule preamble (75 FR 14670, March 26, 2010) and Regulatory Impact Analysis (RIA) (EPA-420-R-10-006) provide further discussion of our approach. These documents are available online at https://www.epa.gov/renewable-fuel-standard-program/renewable-fuel-standard-rfs2-final-rule-additional-resources.

[19] These differences are discussed further in Sections II.D.2 and II.D.3 below.

[20] The memoranda and modeling files are available in the docket. EPA-HQ-OAR-2016-0771.

Sugar beets grown under the U.S. sugar program cannot be used for the purpose of biofuel production, except under very limited conditions specified in the Feedstock Flexibility Program.[21] Therefore, for this analysis, EPA assumed that there would be no change in sugar production on U.S. sugar program-designated acres because of demand for beet sugar for biofuel feedstock use.[22] In our modeling, growers selling sugar beets to sugar processors under the U.S. sugar program in the control case continued to do so regardless of new demand for sugar beets as a biofuel feedstock in the test case. As a result of this assumption, in our modeling, demand for acreage to grow sugar beets for biofuel feedstock could only be fulfilled by converting acres from other crops besides sugar beets, and/or from other land uses besides crop production (e.g., pastureland, Conservation Reserve Program land).

Our analysis also considers the significant restrictions on the trade of sugar beets between the U.S. and other countries. The U.S. does not export beet sugar, as this would violate the terms of participation in the sugar program. While the U.S. does import cane sugar under international agreements, it does not import raw beet sugar.[23] Beet sugar may only enter the U.S. as refined sugar from Canada or Mexico under the North American Free Trade Agreement (NAFTA) and similar trade agreements, or as components of sugar-containing products.[24] This quantity is

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[21] Harry Baumes, et al. (USDA), "Summary of Discussions Between US EPA and USDA Regarding Sugar Beets"
[22] The U.S. sugar program designates acres of land used to grow sugar beets sold to domestic sugar processors who receive price support loans and are regulated by USDA market allotments under the program.
[23] The international agreements that allow for sugar import to the U.S. are primarily governed by NAFTA and the Uruguay Round Agreement on Agriculture, but also by CAFTA. See USDA's website on the Sugar Import Program for more details: https://www.fas.usda.gov/programs/sugar-import-program (Last accessed December 30, 2016).
[24] Mark A. McMinimy, "U.S. Sugar Program Fundamentals," April 6, 2016, https://fas.org/sgp/crs/misc/R43998.pdf.

strictly regulated. EPA is unaware of existing trade agreements that would allow raw beet sugar imports for any purpose, including biofuel production. This makes it unlikely that beet sugar would be imported for use as biofuel feedstock.

Although sugar beets were modeled as grown in the U.S., we also intend that this analysis would cover sugar beets grown and processed into biofuels from other countries and imported to the U.S. as finished biofuel. We expect the vast majority of beet sugar-based biofuel used in the U.S. will come from sugar beets produced in the U.S., and incidental amounts of fuel from crops produced in other nations will not impact our average GHG emissions. Sugar beets require similar climatic regions as those where they are grown in the U.S., and would similarly impact crops such as wheat in those regions while sugar beet pulp would displace corn as livestock feed. Therefore, EPA interprets this upstream analysis as applicable, regardless of the country of origin assuming that sugar beet pulp is used as a livestock feed supplement.

To assess the impacts of an increase in sugar beet demand for renewable fuel production, EPA modeled two scenarios: 1) a control case with "business-as-usual" assumptions[25] and no

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[25] To assess the impacts of an increase in renewable fuel volume from business-as-usual (what is likely to have occurred without the RFS biofuel mandates) to levels required by the statute, we established a control case and other cases for a number of biofuels. The control case included a projection of renewable fuel volumes that might be used to comply with the RFS renewable fuel volume mandates in full. The case is designed such that the only difference between the scenario case and the control case is the volume of an individual biofuel, all other volumes remaining the same. In the March 2010 RFS rule, for each individual biofuel, we analyzed the incremental GHG emission impacts of increasing the volume of that fuel from business as usual levels to the level of that biofuel projected to be used in 2022, together with other biofuels, to fully meet the CAA requirements. Rather than focus on the GHG emissions impacts associated with a specific gallon of fuel and tracking inputs and outputs across different lifecycle stages, we determined the overall aggregate impacts across sectors of the economy in response to a given volume change in the amount of biofuel produced. For this analysis, we compared impacts in the control case to the

biofuel production from sugar beets and 2) a sugar beet biofuel case where 300 million ethanol-equivalent gallons of biofuels are assumed to be from beet sugar in 2022, requiring the use of 12 million wet short tons of sugar beets for biofuel production. The analysis presented in this notice considered all GHG emissions associated with the cultivation and production of sugar beets intended for biofuel feedstock use, as well as emissions from transporting these sugar beets to a biofuel production facility. In lifecycle analysis literature these emissions are often referred to as the "upstream" emissions, because they occur upstream of the fuel production facility (i.e., before the biofuel feedstock arrives at that facility).

The analysis presented in this notice does not include fuel production or "downstream" emissions, which consists of emissions associated with fuel transport and fuel combustion. Once comments on the upstream emissions described in this notice have been considered, we intend to combine the upstream analysis with the fuel production and downstream emissions associated with fuel produced at an individual biofuel facility to determine the lifecycle GHG emissions associated with that fuel. This lifecycle analysis would reflect any differences in emissions that may exist between producing different types of biofuels from sugar beets. Our analysis of the upstream emissions associated with sugar beets assumed that non-cellulosic sugars are extracted from the beets before the sugars are converted, and that the beet pulp would then be sold into feed markets. Fuel production methods that also convert the pulp into fuel (e.g., through pyrolysis of the beet) or use the pulp for other purposes may not be compatible with this analysis.

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impacts in a new sugar beets case. The control case used for the March 2010 RFS rule, and used for this analysis, has zero gallons of sugar beet biofuel production.

We evaluated a scenario with biofuels produced from this amount of sugar beets for multiple reasons. Although biofuel production from sugar beets is currently small in the U.S., recent trends in domestic sugar beet yields and acreage indicate that 12 million wet short tons of sugar beets could be produced as biofuel feedstocks if a significant market demand emerged. An additional 12 million wet short tons of sugar beets would represent a 34 percent increase in U.S. sugar beet cultivation compared to 2015 levels.[26] According to USDA data, harvested acres of sugar beets since 2010 were, on average, about 30 percent lower than their most recent peak levels in the 1990s, an average difference of approximately 360,000 harvested acres.[27] Increasing beet yields over time has reduced the number of acres needed to satisfy production targets under the U.S. sugar program.[28] National average sugar beet yields since 2010 have been approximately 25 percent higher than yields during the 1990s, and reached almost 31 wet short tons per acre in the 2015 crop year.[29] Were beet acres to return to their 1990s peak, the additional approximately 360,000 harvested acres would produce about 11.2 million wet short tons of beets at these 2015 yield levels. However, based on the steady increase in yields over time, it seems likely that beet yields will continue to increase between now and 2022. If national average beet yields reach at least 33.4 wet short tons per acre by 2022, a fairly modest increase of about 8 percent over 2015 levels, an additional 12 million wet short tons of beets could be produced on

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[26] See, USDA, "Sugarbeet Area and Planted Harvested Yield and Production States and United States 2013-2015," in *Crop Production 2015 Summary, January 2016,* ISSN: 1057-7823, http://usda.mannlib.cornell.edu/usda/current/CropProdSu/CropProdSu-01-12-2016.pdf. This assumes an ethanol conversion rate of 25 gallons of ethanol/wet short ton of beets.
[27] USDA, "NASS Quick Stats", https://quickstats.nass.usda.gov (Last Accessed: November 16, 2016).
[28] USDA, "NASS Quick Stats", https://quickstats.nass.usda.gov (Last Accessed: November 16, 2016).
[29] USDA, "NASS Quick Stats", https://quickstats.nass.usda.gov (Last Accessed: November 16, 2016).

these additional 360,000 acres. Since further expansion of beet area beyond the historical peak is also possible, an increase in beet production of 12 million wet short tons appears to be very feasible. We welcome comment on this assumption.

In our analysis, FASOM allowed for sugar beet production in all areas of the continental 48 states where sugar beets had been grown historically, including states and areas that do not currently take part in the U.S. sugar program. The model was allowed to determine which of these regions would be optimal for growing sugar beets for biofuel feedstock, based on least cost of production and transport, and considering the opportunity cost of using that land for other uses (e.g., to produce other crops, grazing, forestry). The factors that contributed to these crop production choices include crop yield, input quantities, and growing strategies.

Following the methodology established in the March 2010 RFS rule, EPA used the FAPRI model to evaluate the international impacts of producing and transporting 12 million wet short tons of sugar beets for biofuel production in the U.S. The FAPRI model included a representation of the U.S. sugar program, and modeled domestic sugar production as a function of this program. Production and consumption levels in the U.S. were set according to the parameters of the sugar program and were not affected by market forces. Because the existing U.S. sugar production module in FAPRI did not respond to market forces, for modeling purposes EPA had to make assumptions regarding in which regions sugar beets for biofuel feedstock use would be grown. Crop yields and the quantity of crop area displaced by expanded sugar beet production also had to be set by assumption, since the U.S. sugar module in FAPRI lacks market forces to create demand-pull for new beet acres. In order to derive the quantity of crop area displaced, EPA used a crop yield of approximately 26 wet short tons per acre, the 10-year national average yield for sugar beets (for crop years 2005 through 2014).[30] Actual yields on any given acre may be higher or lower than this assumed value, based on factors such as location, annual variation in growing conditions, growing practices, and crop rotation strategies. Because the FAPRI analysis assumed to displace acres in North Dakota and California, we did not believe that it was appropriate to use the USDA 2022 national average projections for sugar beets yield. As an alternative, EPA believes using the 10-year national average was a reasonable assumption for our international agricultural sector modeling. The increase in sugar yield trends over the last few decades suggests that future yields are unlikely to be lower than the 10-year average. As further support for our yield assumptions in FAPRI, we note that FASOM projected sugar beet yields in 2022 that are close to the assumptions used in FAPRI.[31] We welcome comment on this assumption.

For the purposes of FAPRI modeling, EPA assumed that sugar beets for fuel use would be produced in equal amounts in North Dakota and California for the following reasons: at the onset of our analysis, these were the regions with indications of significant sugar beet biofuel interest.[32] They are also both regions with a long history of sugar beet production. As a

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[30] USDA, "NASS Quick Stats", https://quickstats.nass.usda.gov (Last Accessed: November 16, 2016).

[31] See "Sugar Beets for Biofuel Upstream Analysis Technical Memorandum" in the docket for details. EPA-HQ-OAR-2016-0771.

[32] At the time of this modeling we had received the petitions from Green Vision Group proposing to produce ethanol from sugar beets grown in North Dakota and Tracy Renewable Energy proposing to produce ethanol from sugar beets grown in California but we had not received the petition from Plant Sensory Systems proposing to produce ethanol from sugar beets grown in Florida. EPA does not expect results would have varied significantly if sugar beets had been modeled by assumption in Florida under FAPRI due to the similarity of these results to the results from FASOM.

simplifying assumption, EPA assumed that all crops grown in each of these regions were displaced by sugar beets proportionally to their crop area in the control case. We recognize there are significant differences in the way the sugar beet biofuel scenarios were implemented in FASOM and FAPRI for this analysis. For example, FASOM chose to produce all sugar beets for biofuels in North Dakota, whereas in FAPRI we modeled this production in North Dakota and California by assumption. Since these modeling exercises occurred concurrently, not sequentially, we could not anticipate what choices FASOM would make at the outset of our FAPRI modeling. This led to some differences in the regions utilized to produce beets. However, the nationwide agricultural market results projected by FASOM and FAPRI were similar, due to similar dominant trends in feed markets and crop exports at the national level. The similarity of these relevant national market results between the two models, despite differences in U.S. growing regions, indicates that the international impacts projected by the FAPRI model would not have been significantly different if we had applied the growing assumptions from FASOM. These results are discussed below and are available in the docket for this notice.[33] We welcome comment on these assumptions and our results.

The sugar beet scenario modeled included a number of key assumptions, such as biofuel and pulp yields per wet short ton of beets, and the amount of corn livestock feed displaced per pound of pulp. These key assumptions are discussed below. Information on additional

[33] See EPA-HQ-OAR-2016-0771.

assumptions, including sugar beet crop inputs (e.g., fertilizer, energy) is available in the docket for this notice.

In conducting research for this analysis, we located sources for beet pulp yield of 0.06 dry short tons of sugar beet pulp per wet short tons of sugar beets[34] and displacement rates of 0.9 pounds of corn feed displaced in cattle diets[35] for every pound of sugar beet pulp. In livestock production, the fibrous sugar beet pulp is used as a roughage replacement making it of use primarily for ruminants rather than other types of livestock.[36] In our analysis, sugar beet pulp use by the livestock market was an important factor leading to GHG reductions. Therefore this notice evaluates only using the non-cellulosic portion of sugar beets for biofuel production.

2. Domestic Impacts

On the basis of least cost, FASOM chose to grow all sugar beets in North Dakota, with approximately 477,000 acres of land required to grow the additional sugar beets.

The vast majority of the new sugar beet acres in North Dakota was from displacement of other crops rather than from new cropland (432,000 acres from displaced crops, or nearly 91 percent of needed acres). Increasing sugar beet production in North Dakota primarily displaced wheat

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[34] Panella, Lee and Stephen R. Kaffka, "Sugar Beet (*Beta vulgaris L)* as a Biofuel Feedstock in the United States." Chapter 10 in Sustainability of the Sugar and Sugar Ethanol Industries; Eggleston, G.; ACS Symposium Series; American Chemical Society: Washington DC, 2010, pp. 165.

[35] To make a simplifying assumption, we averaged the value from corn in backgrounding diets and finishing diets. Lardy, Greg, and Rebecca Schafar, "Feeding Sugar Beet Byproducts to Cattle," North Dakota State University, May 2008, pp. 2.

[36] Harry Baumes, et al. (USDA), "Summary of Discussions Between US EPA and USDA Regarding Sugar Beets"

acreage, but also soybeans, corn, and hay among other crops.[37] Most of these displaced crops shifted to other U.S. regions, and some crops, such as soybeans, shifted to new acreage that was more productive than the North Dakota acres from where they were displaced. Table II.1 indicates that production levels for hay, soy, and most other crops are maintained.[38] However, national crop area and production for wheat and corn declined significantly.

Table II.1 Changes in U.S. Production (Million Pounds) and Harvested Area (Thousand Acres) in 2022 Relative to Control Case [39]

	Production Difference from Control Case (Million Pounds)	Harvested Area Difference from Control Case (Thousand Acres)
Sugar Beets	+23,976	+477
Hay	+8	-106
Corn	-867	-96
Wheat	-352	-98
All Else	+3	-56
Total	**+22,768**	**+121**

The reductions in corn and wheat production were driven by different proximate causes (though both were ultimately driven by increased demand for sugar beets) and led to somewhat different impacts on commodity use and trade. In the case of wheat, the decline in production led to a decline in exports. As shown in Section II.B.3, the decline in wheat exports created pressure on international wheat markets and wheat production increased outside the U.S.

[37] See "FASOM Sugar Beets Results" in the docket. EPA-HQ-OAR-2016-0771.
[38] Soy is captured in the "All Else" category in Table II.1. See "FASOM Sugar Beets Results" in the docket EPA-HQ-OAR-2016-0771 for more detail.
[39] Totals may differ from subtotals due to rounding.

In the case of corn, the potential market impacts were mitigated by the increased availability of sugar beet pulp into U.S. feed markets as a result of beet sugar biofuel production. As described in Section II.A, sugar beet pulp is a co-product used as livestock feed supplement, mainly substituting for corn. Based on the FASOM results for 2022, approximately 1.4 billion pounds of sugar beet pulp were produced and sent to the feed market. In turn this displaced approximately 1.2 billion pounds of corn, which was significantly greater than the approximately 867 million pounds of corn production lost to displaced acres. This led to a decrease in total demand for corn in U.S. markets and, as a result, U.S. exports of corn increased. As discussed in Section II.B.3 below, this reduced the price of corn internationally and lessened the demand pull for corn to be grown in other countries.

The rest of the needed sugar beet acres in North Dakota, approximately 46,000 acres, came from new cropland, particularly from cropland pasture (high-value pasture land that can also be utilized as cropland with minimal preparation) and from acres that would otherwise take part in the Conservation Reserve Program. Pasture area rose modestly in some other states causing the conversion of some forest acres to pasture. This relatively small decrease in forestland pushed up prices slightly for forest products, leading foresters to intensify growth on their stands. Relative to other feedstocks EPA has evaluated for the RFS program, these domestic shifts in land use were minor, and after the various land use changes were considered the net domestic land use change emissions impacts were close to zero.

3. International Impacts

In the FAPRI model, the expansion of sugar beet cropland used to produce biofuel feedstock also led to increases in corn exports and decreases in wheat exports. Similar to the drivers of the domestic results discussed in Section II.B.2, beet production displaced wheat acres, but the beet pulp co-product reduced domestic demand for corn. Further, the magnitude of these export impacts was quite similar between the two models, as shown in Table II.2 below.[40]

Table II.2 Changes in U.S. Corn and Wheat Exports in 2022 Relative to Control Case by Model (Million Pounds)

	Difference from Control Case in FASOM	Difference from Control Case in FAPRI
Corn	+307	+355
Wheat	-292	-281

With sugar beet pulp displacing corn feed, FAPRI modeling indicated that in 2022, both corn production and acreage would decline globally. Production outside the US of certain other crops however increased in response to U.S. increasing demand for sugar beets; most significantly wheat and soybeans. Wheat increased internationally in terms of both production and acreage, with a strong response particularly in India. Soybean acres and production also increased, particularly in Brazil. Table II.3 below summarizes the non-U.S. increases in harvested area by crop type, while Table II.4 shows which countries had the largest impacts.

[40] Impacts on the exports of other crops were relatively minor, but interested readers can examine the full set of FAPRI crop trade impacts in the docket.

Table II.3 Non-U.S. Harvested Area by Crop in 2022 Relative to Control Case (Thousand Acres)[41]

	Difference from Control Case
Sugar Beets	0
Corn	-45
Wheat	+43
Soybeans	+20
All Else	+37
Total	**+55**

As increasing sugar beet pulp use for livestock feed in the U.S. freed up more corn for export, international livestock feed prices declined modestly, and with it was a small rise in meat production globally. Many of these changes occurred in Brazil and this caused some expansion in grazing land, including in the Amazon region. This caused further international land use change impacts, as shown in Table II.4 below.

Table II.4 Non-U.S. Changes in Agricultural Land by Region in 2022 Relative to Control Case (Thousand Acres)[42]

	Change in Area Harvested	Change in Pasture Acres	**Total Change in Acres**
Brazil	+9	+20	**+29**
India	+15		**+15**
Rest of Non-USA	+32		**+32**
Total Non-USA			**+75**

[41] These totals do not include pastureland in Brazil. Totals may differ from subtotals due to rounding.
[42] Totals may differ from subtotals due to rounding. Brazil totals include pastureland. Other regions are cropland only.

4. Feedstock Transport

When harvested, sugar beets are heavy and perishable; therefore, transport of sugar beets from field to processing site is expected to occur over short distances. Information from stakeholders and literature states that sugar beets used for biofuels are shipped by truck from point of production to the plant with typical distances for transport around 30 miles.[43] GHG emissions for the transport of sugar beets are based on emission factors developed for the March 2010 RFS rule for trucks including capacity, fuel economy, and type of fuel used.[44]

5. Results of Upstream GHG Lifecycle Analysis

As described above, EPA analyzed the GHG emissions associated with feedstock production and transport. Table II.5 below breaks down by stage the calculated GHG upstream emissions for producing biofuels from sugar beets in 2022.

Table II.5 Upstream GHG Lifecycle Emissions for Sugar Beets (gCO_2-eq/wet short ton)

Process	Emissions (g CO_2-eq/wet short ton)
Net Agriculture (w/o land use change)	+21,615
Domestic Land Use Change	-882
International Land Use Change, Mean (Low/High)	+16,038 (+9249/ +23,672)
Feedstock Transport	+8,183

[43] Farahmand, K., N. Dharmadhikari, and V. Khiabani. "Analysis of Transportation Economics of Sugar-Beet Production in the Red River Valley of North Dakota and Minnesota using Geographical Information System." Journal of Renewable Agriculture 7(2013):126-131.

[44] The March 2010 RFS rule preamble (75 FR 14670, March 26, 2010) and Regulatory Impact Analysis (RIA) (EPA-420-R-10-006) provide further discussion of our approach. These documents are available online at https://www.epa.gov/renewable-fuel-standard-program/renewable-fuel-standard-rfs2-final-rule-additional-resources.

Total Upstream Emissions, Mean (Low/High)	**+44,954** (+38,210/ +52,588)

Net agricultural emissions included domestic and international impacts related to changes in crop inputs such as fertilizer, energy used in agriculture, livestock production, and other agricultural changes in the scenario modeled. Increased demand for sugar beets resulted in positive net agricultural emissions relative to the control case. Compared with other crops, sugar beets required relatively high levels of agricultural chemical inputs (e.g., herbicides and pesticides).[45] Domestic land use change emissions were close to zero for sugar beets, as described in Section II.B.2.

International land use change emissions increased as a result of demand for sugar beets. The increase in international land use change emissions for sugar beets was significantly larger than the decrease in domestic land use change emissions. This is because increased demand for sugar beets led to a significant reduction in key U.S. crop exports (e.g., wheat exports), but very little change in domestic consumption of agricultural goods. These greater international emissions led to a net increase in global land use change emissions. Feedstock transport included emissions from moving sugar beets from the farm to a biofuel production facility, as described in Section II.B.4 above.

[45] Harry Baumes, et al. (USDA), "Summary of Discussions Between US EPA and USDA Regarding Sugar Beets"

6. Fuel Production and Distribution

Sugar beets are suitable for the same biofuel conversion processes as sugarcane. In Europe, where sugar beets are widely used as biofuel feedstock, virtually all of the fuel is non-cellulosic beet sugar ethanol produced through fermentation with the beet pulp sold into the feed markets. Based on these data, and on information from our petitioners and other stakeholders, EPA anticipates that most biofuel produced from sugar beets in the U.S. would also be from the non-cellulosic sugars via fermentation. Our upstream analysis would apply for all facilities where non-cellulosic beet sugar is converted to biofuel and the co-product beet pulp is used as animal feed.

Given the importance of the beet pulp co-product on the upstream GHG emissions associated with beet pulp, pathways that do not produce a beet pulp feed coproduct, or use it for purposes other than animal feed, may not be compatible with our analysis. EPA would likely need to conduct supplemental upstream GHG analysis in order to determine the lifecycle GHG emissions associated with fuels produced under these types of pathways.

After reviewing comments received in response to this action, EPA will combine the evaluation of upstream GHG emissions associated with the use of sugar beet feedstock with an evaluation of the GHG emissions associated with individual producers' production processes and finished fuels to determine whether fuel produced at petitioners' facilities from the sugar in sugar beets satisfy the CAA lifecycle GHG emissions reduction requirements for renewable fuels. Each biofuel producer seeking to generate Renewable Identification Numbers (RINs) for non-grandfathered volumes of biofuel from sugar beets will need to submit a petition requesting

EPA's evaluation of their new renewable fuel pathway pursuant to 40 CFR 80.1416 of the RFS regulations, and include all of the information specified at 40 CFR 80.1416(b)(1).[46]

Because EPA is evaluating the GHG emissions associated with the production and transport of sugar beet feedstock through this notice and comment process, petitioners requesting EPA's evaluation of biofuel pathways involving sugar beet feedstock need not include the information for new feedstocks specified at 40 CFR 80.1416(b)(2). Based on our evaluation of the upstream GHG emissions attributable to the production and transport of sugar beet feedstock, including our assumptions regarding the average yield of ethanol in mmBtu per wet short ton of sugar beets used, EPA anticipates that if a facility produces emissions of no more than approximately 23 kgCO_2e/mmBtu of ethanol, the fuel produced would meet the 50 percent advanced biofuel GHG reduction threshold.[47] If a facility produces no more than 53 kgCO_2e/mmBtu of ethanol, EPA anticipates it would meet the 20 percent renewable fuel GHG reduction threshold. EPA will evaluate petitions for fuel produced from sugar beet feedstock on a case-by-case basis, and will make adjustments as necessary for each facility including consideration of differences in the

[46] Petitioners with pending petitions involving use of sugar from sugar beets as feedstock will not be required to submit new petitions. However, if any information has changed from their original petitions, EPA will request that they update that information.

[47] In this case, emissions produced by the facility refers to fuel production emissions, including emissions associated with energy used for fuel, feedstock and co-product operations at the facility. For more details on the assumptions used in this analysis, see "Sugar Beets for Biofuel Upstream Analysis Technical Memorandum" in the docket. EPA-HQ-OAR-2016-0771.

yield of ethanol per wet short ton of sugar beets used.[48] We welcome comments on this application of our upstream analysis.

7. Risk of Potential Invasiveness

Sugar beets were not listed on the Federal noxious weed list nor did they appear on USDA's composite listing of introduced, invasive, and noxious plants by U.S state.[49,50] Based on consultation with USDA, EPA does not believe sugar beets pose a risk of invasiveness at this time. Current cultivars of sugar beets require extensive weed management to survive.[51] However, USDA notes that future cross breeding, hybridization, and genetic manipulation could change the invasiveness potential of beets, in which case a re-evaluation may be required. [52] Based on currently available information, EPA does not believe monitoring and reporting of data for invasiveness concerns would be a requirement for biofuel producers generating fuel from sugar beets at this time.

III. Summary

EPA invites public comment on its analysis of GHG emissions associated with the production and transport of sugar beets as a feedstock for biofuel production. This notice

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[48] For example, EPA may need to consider additional feedstock transportation emissions in cases where beet sugar extraction and biofuel production do not occur in the same location, as may be the case for biofuel produced under the USDA Feedstock Flexibility Program.

[49] USDA, "Federal Noxious Weed List," July 13, 2016, https://www.aphis.usda.gov/plant_health/plant_pest_info/weeds/downloads/weedlist.pdf.

[50] USDA, "State and Federal Noxious Weeds List," accessed November 17, 2016, http://plants.usda.gov/java/noxComposite.

[51] Harry Baumes, et al. (USDA), "Summary of Discussions Between US EPA and USDA Regarding Sugar Beets"

[52] Harry Baumes, et al. (USDA), "Summary of Discussions Between US EPA and USDA Regarding Sugar Beets"

analyzes a non-cellulosic sugar beet-to-biofuel production process. Although EPA has not received a petition for cellulosic sugar beet biofuel production, the agency is aware of interest in this process and invites comment on the analysis of beet pulp and its effect on agricultural markets. EPA will consider public comments received when evaluating petitions received pursuant to 40 CFR 80.1416 that involve pathways using sugar beets as a feedstock.

Dated: January 18, 2017.

Christopher Grundler, Director
Office of Transportation and Air Quality
Office of Air and Radiation.

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