February 14, 2022

Preliminary Rebuttal to PNAS Report: "Environmental outcomes of the U.S. Renewable Fuel Standard" (Lark *et al*.)

A new report published today in the *Proceedings of the National Academy of the Sciences*, funded by the National Wildlife Federation, purports to examine the "environmental outcomes" of the Renewable Fuel Standard. In keeping with their previous "research" on biofuels and the RFS, the authors of this new paper precariously string together a series of worst-case assumptions, cherry-picked data, and disparate results from previously debunked studies to create a completely fictional and erroneous account of the environmental impacts of the Renewable Fuel Standard.

Below are a number of key facts that were purposely omitted from the new report by Lark *et al*.

FACT: Recent studies show that corn ethanol reduces GHG emissions by 40-50 percent compared to gasoline, even when emissions from hypothetical land use changes are included.

Today's corn ethanol already reduces GHG emissions by roughly half, on average, compared to gasoline. According to the Department of Energy's Argonne National Laboratory, typical corn ethanol provides a 44 percent GHG savings compared to gasoline, including land use change emissions.[1] Similarly, researchers affiliated with Harvard University, MIT, and Tufts University concluded that today's corn ethanol offers an average GHG reduction of 46 percent versus gasoline.[2] In addition, the California Air Resources Board (CARB) found that ethanol used in the state in 2020 reduced emissions by 41 percent, on average, compared to gasoline. From 2011 to 2020, CARB data show that the use of ethanol cut GHG emissions from the California transportation sector by 27 million MT CO2e, more than any other fuel used to meet the state's Low Carbon Fuel Standard requirements.[3]

FACT: The law establishing the RFS2 prohibits the use of crops from newly expanded cropland.

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[1] Lee, U., Kwon, H., Wu, M. and Wang, M. (2021), Retrospective analysis of the U.S. corn ethanol industry for 2005–2019: implications for greenhouse gas emission reductions. *Biofuels, Bioprod. Bioref*., 15: 1318-1331. https://doi.org/10.1002/bbb.2225

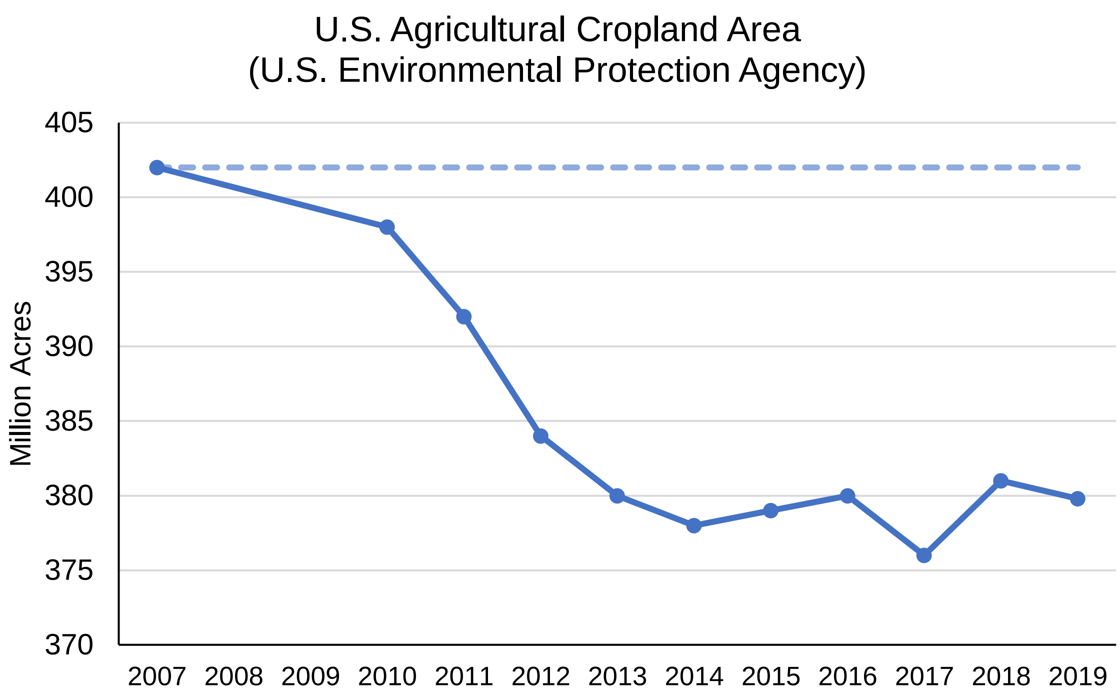
[2] Melissa J Scully *et al* (2021), Carbon intensity of corn ethanol in the United States: state of the science. *Environ. Res. Lett.* **16** 043001. https://iopscience.iop.org/article/10.1088/1748-9326/abde08

[3] CARB. "Low Carbon Fuel Standard Reporting Tool Quarterly Summaries." Viewed Nov. 20, 2021. https://ww2.arb.ca.gov/resources/documents/low-carbon-fuel-standard-reporting-tool-quarterly-summaries

As acknowledged by Lark *et al*., “the RFS legislation contains several environmental safeguards to try to prevent perverse outcomes…” One of those environmental protections requires that biofuel producers may only use crops from agricultural land that had been cleared or cultivated prior to 2007. Thus, any crops produced on newly expanded cropland (i.e., after 2007) would not be eligible for biofuel production under the RFS.

FACT: According to EPA, U.S. cropland has decreased—not expanded—since the RFS2 was adopted in 2007.

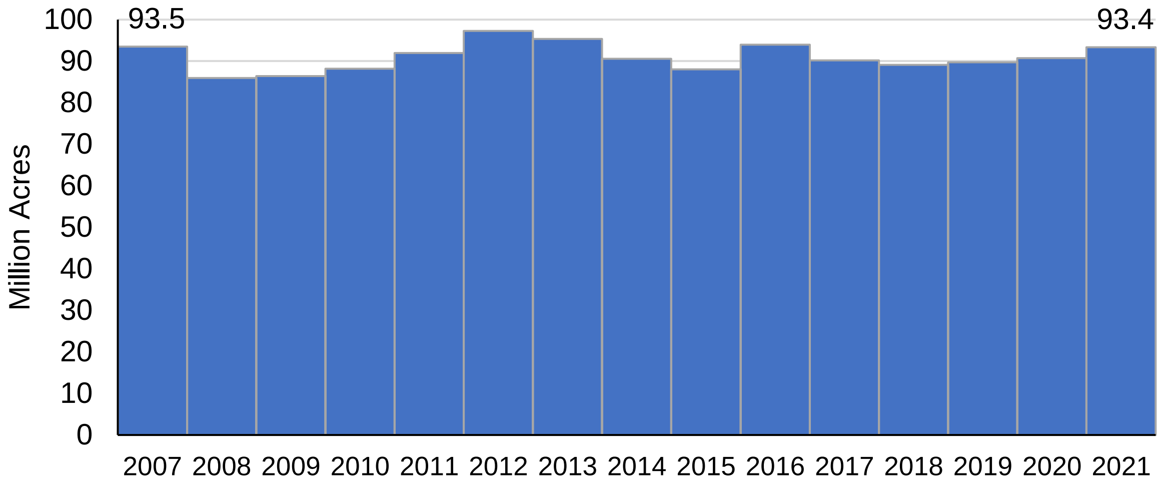
To ensure compliance with the statutory limitation on cropland, EPA conducts an annual assessment of the amount of U.S. agricultural cropland. EPA’s annual assessment shows that U.S. cropland has *receded* since the RFS2 was adopted in 2007, directly refuting the claim from Lark *et al.* that the RFS has somehow caused cropland to expand since 2007. According to EPA, the total amount of U.S. cropland in recent years has been 20-25 million acres *lower* (5-6 percent) than the amount of cropland in 2007 when the RFS2 was adopted (2020 and 2021 data have not yet been published by EPA).



FACT: Corn acreage has been relatively flat since the RFS2 was adopted in 2007.

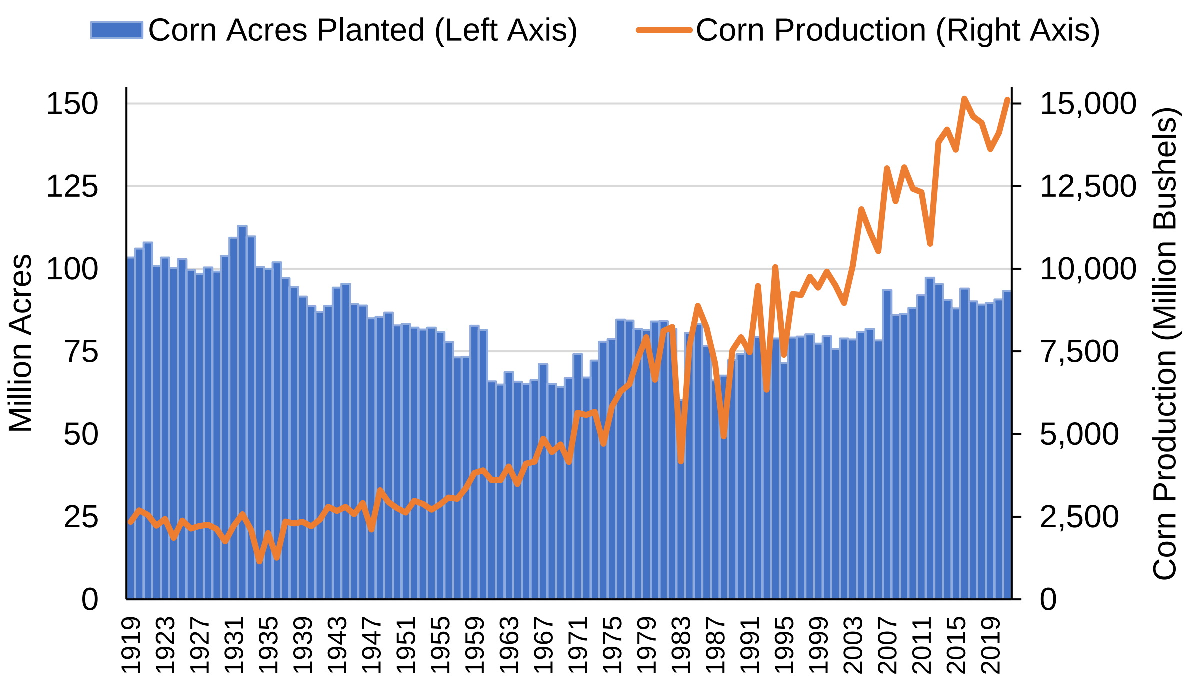
Looking specifically at corn acres, data from USDA show that the amount of land planted to corn in 2021 was essentially identical to the amount of land planted to corn in the spring of 2007 before the RFS2 was adopted. In fact, corn acres planted have been relatively consistent since 2007, averaging 91 million acres per year.

U.S. Planted Corn Acres, 2007-2021
(U.S. Department of Agriculture)



In addition, USDA data show that the amount of land dedicated to corn production today is well below historical levels and far below (18 percent) the peak level of 113 million corn acres in 1932.

U.S. Corn Acres Planted and Total Corn Production
(U.S. Department of Agriculture)



FACT: The additional corn supply needed to meet increased ethanol demand has come primarily from yield increases and secondarily from crop switching—not from acreage expansion.

As ethanol production has grown under the RFS program, the additional corn needed has come primarily from increased efficiency on existing cropland—not from expanding acreage.

For example, U.S. farmers planted 86 million acres of corn in 2008 (the first year of the Lark *et al.* study period) and harvested 78.6 million acres to produce a crop of 12.04 billion bushels. Thus, the average yield that year was 153.3 bushels per acre. In 2018 (the record-high year for ethanol production), farmers planted 89.1 million acres and harvested 81.3 million acres to produce a crop of 14.42 billion bushels. The average yield in 2018 was 176.4 bushels per acre.

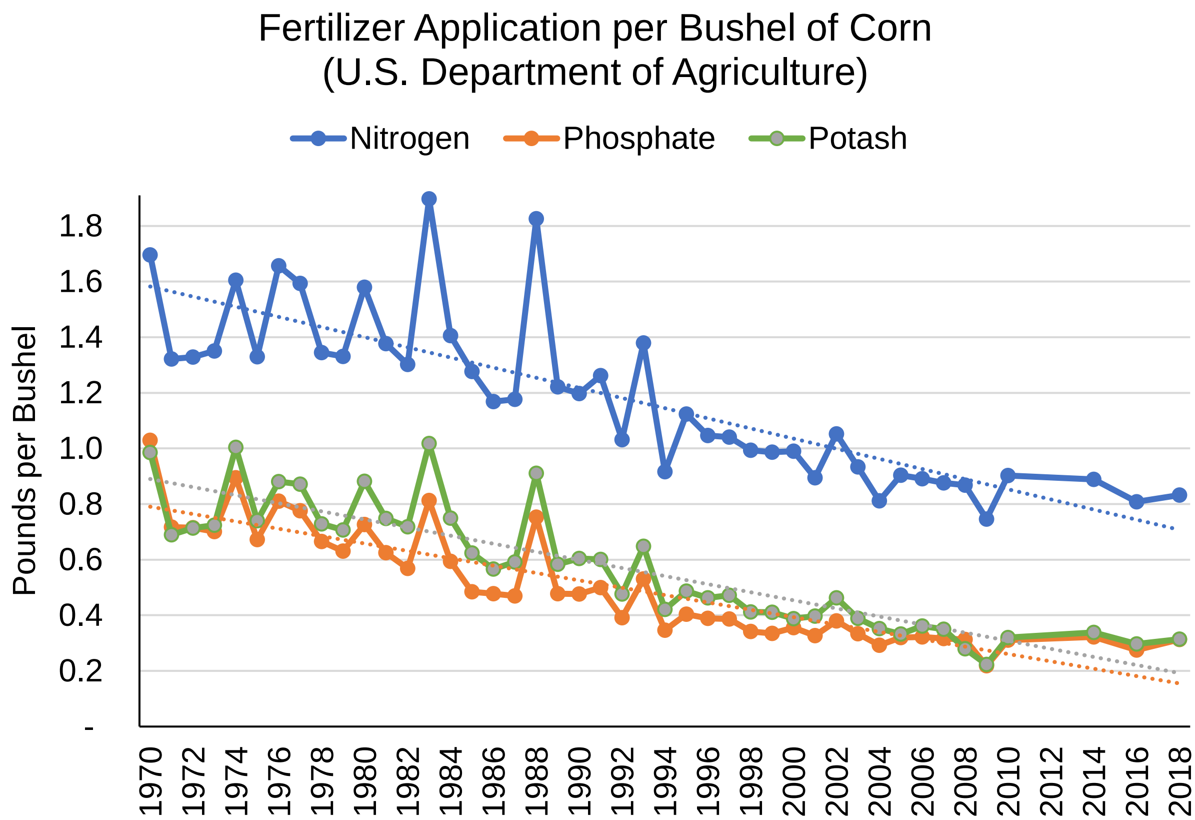
Thus, farmers produced 2.38 billion bushels more (20 percent) in 2018 than in 2008, but used only 2.7 million more harvested acres (3 percent) to do it. Importantly, the slight increase in corn acres came from reductions in planted acres for other crops (like wheat and cotton), not from expanding cropland. Yield growth alone accounted for about 80 percent of the corn production increase between 2008 and 2018. Meanwhile, corn use for ethanol was 2.32 billion bushels higher in 2018 than in 2008, meaning the increase in corn production slightly outpaced the increase in corn use for ethanol.

	2008	**2018**	**Change**	**% Change**
Total Agricultural Cropland (m. acres)[1]	402.0	381.0	-21.0	-5.1%
Corn Acres Planted (m. acres)[2]	86.0	89.1	3.1	3.6%
Corn Acres Harvested (m. acres)	78.6	81.3	2.7	3.4%
Yield per Acre (bu. per acre)	153.3	176.4	23.1	15.1%
Corn Production (m. bu.)	12,043	14,420	**2,377**	19.7%
Ethanol Production (m. gal.)[3]	9,309	16,091	6,782	72.9%
Corn Use for Ethanol & Co-products (m. bu.)[4]	3,325	5,646	**2,321**	69.8%

1. EPA
2. USDA
3. EIA
4. RFA based on average ethanol yield per bushel

FACT: The amount of fertilizer required to produce a bushel of corn has fallen dramatically in recent decades.

The Lark et al. paper suggests that the RFS is somehow responsible for "increasing annual nationwide fertilizer use by 3 to 8%." However, data from USDA show that total fertilizer (nitrogen, phosphate, and potash) application on corn in recent years is slightly less than the total amount of fertilizer typically applied to corn in the 1970s and 1980s. However, because today's corn output is so much larger than in the 1970s and 1980s, the amount of fertilizer required to produce a bushel of corn has dropped precipitously. USDA data show that nitrogen fertilizer use per bushel is down more than 50 percent since 1970, while phosphate and potash use are each down nearly 70 percent. Clearly, fertilizer use for corn production has not increased since the RFS2 was adopted in 2007.



FACT: The methodology used by *Lark et al.* to estimate land use changes is highly flawed and has been rejected after rigorous critique by the scientific community.

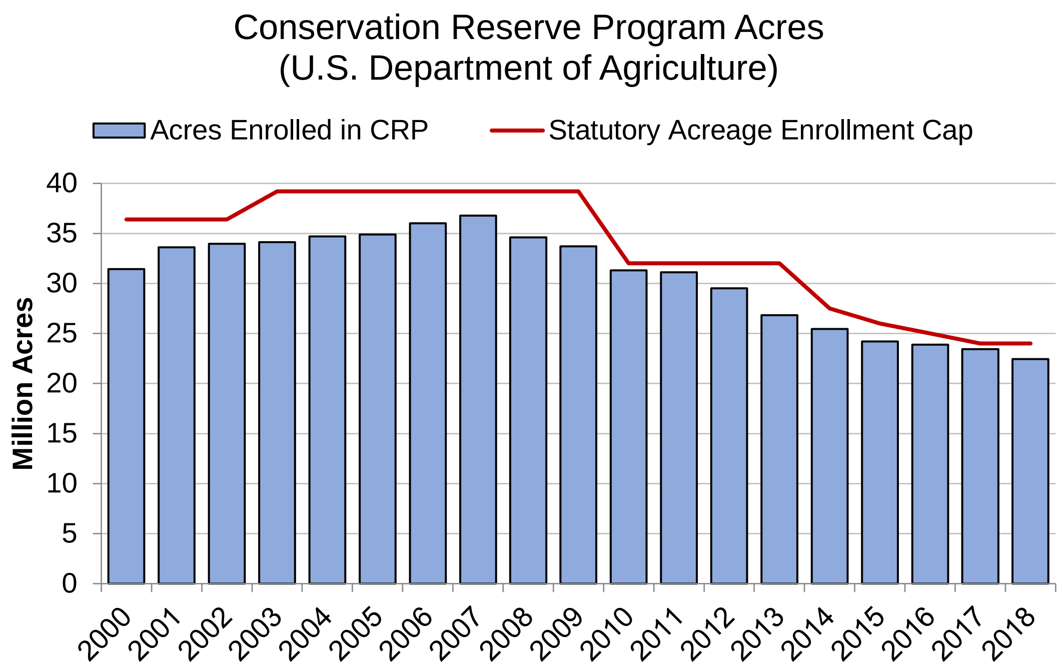
Despite the fact that EPA and USDA data show no overall cropland expansion since the RFS2 was adopted, Lark et al. claim that “native” grassland with high carbon storage has been converted to corn production because of the RFS. This claim is based on previous studies conducted by Lark and others that rely on comparisons of satellite imagery from different time periods.

If, for example, a satellite image from 2008 shows a particular parcel of land is covered in grass, but a satellite image from 2016 shows that same parcel is planted to corn, the authors would treat this as a conversion of “native” grassland to corn. Using an opaque methodology, they then assign that “new” corn production to ethanol and allocate the assumed emissions from the land conversion to the ethanol. There are multiple problems with this approach.

First, the satellite tools used by Lark and others have great difficulty distinguishing between different land cover types. For example, one tool relied heavily upon by Lark et al. (USDA’s “Cropland Data Layer,” or CDL) often cannot tell the different between wheat, alfalfa hay, grass, and other land cover types. And even if the tools could identify land covered in grass with a high degree of certainty, they cannot distinguish between grass pastureland, grass hay, land enrolled in the Conservation Reserve Program, and “native” grassland. Of course, these land cover types would have much different carbon storage profiles. Yet, Lark et al. treat all of these land cover types (sometimes also including wheat, alfalfa and other crops) as “native” grassland. USDA, which maintains several of the tools used by Lark et al., has warned that, “Unfortunately, the grassland-related categories have traditionally *had very low classification accuracy* in the CDL.”

Second, the authors attempt to characterize these supposed land cover changes as “empirical” and “observed,” suggesting that they actually verified these supposed conversions with their own eyes. This is not the case. Rather, they are relying on highly uncertain and error-prone satellite images for their purported “empirical observations” of land use changes.

In addition, any transitions of non-cropland into cropland since the RFS2 was adopted are most likely explained by expired CRP land returning to cropland, not conversion of “native” grassland. Yet, from a carbon emissions standpoint, the Lark et al. methodology treats a transition of CRP ground back to cropland the same as a conversion of native grassland to cropland. In any case, it is incorrect to argue that the return of some former CRP land to crop production is solely due to the RFS. Rather, Congress has repeatedly lowered the cap on the amount of land eligible for enrollment in CRP, dropping the limit from 39 million acres in 2008 (the first year of the Lark et al. study period) to just 25 million acres in 2016 (the final year of the study period). Thus, it should be no surprise that some of the land no longer eligible for CRP enrollment returned to crop production.



The obvious flaws in the methodology used by Lark *et al.* and several of the underlying studies have been examined and critiqued in detail by, among others, the following:

- Remote sensing experts at Southern Illinois University
    - https://ethanolrfa.org/file/1833/SIUE-Rebuttal-on-USDA-CDL-Use.pdf
    - https://ethanolrfa.org/file/1834/SIUE-Review-of-Land-Use-Change-Literature-07-2019.pdf

- Energy economists and lifecycle assessment experts from Northwestern University, the Dept. of Energy's Argonne National Laboratory, DOE's Oak Ridge National Laboratory University of Illinois-Champaign/Urbana, and University of Illinois-Chicago
    - https://ethanolrfa.org/file/2005/ijgi-10-00281.pdf
    - https://ethanolrfa.org/file/807/Measured-extent-of-agricultural-expansion-depends-on-analysis-technique_Dunn-et-al_2016.pdf
    - https://ethanolrfa.org/file/1447/1373e8a3f091431ad5_g0m6ibjcr.pdf
    - https://ethanolrfa.org/file/2001/LUC-Ethanol-Plant-Proximity-Crop-Prices_Li-et-al_2018-12.pdf

- Economists at the Renewable Fuels Association
    - https://ethanolrfa.org/file/1932/USDA-Data-Show-Cropland-Reductions-in-Counties-with-Ethanol-Plants-from-1997-2012.pdf
    - https://ethanolrfa.org/media-and-news/category/news-releases/article/2015/04/university-of-wisconsin-study-based-on-shaky-foundation-of-faulty-data-and-conclusions
    - https://ethanolrfa.org/file/1814/Wisconsinethanolresponse11.15.pdf