Cerulogy

Why worry about land use change?

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Dr Chris Malins

About me

- Director of the consultancy Cerulogy
- Experts on alternative fuel and climate change policy
- Working with the European Commission on the Innovation Fund and the Carbon Removals Certification Framework
- Previously:
  - Fuels Lead for the International Council on Clean Transportation 2010-2016
  - Communications Specialist for the UK Renewable Fuels Agency 2008-2010
  - Part of LCFS advisory panel, 2011 and 2014

Basic framing

- Land is fundamental to feedstock-crop production
- Land that is fit for agriculture has carbon stored in biomass and soil
- Converting land to crop production releases some of this carbon
- In general it would take decades to 'recover' that carbon by growing biofuel feedstocks and displacing fossil fuels
  - This is true even for relatively low carbon-stock shrubland or grassland
  - For forest conversion, or worse peat drainage, payback could be centuries
- **Biofuels would not work as climate policy if the cultivated area was made available solely by land use change**

Mass conservation and the logic of indirect land use change

- Crop-feedstocks must come from somewhere
- That means some combination of:
  1. Drawing down stocks
     - Cannot continue indefinitely
  2. Reducing demand in other sectors
     - Food-vs.-fuel
  3. Increasing productivity
     - Higher yields; increased cropping intensity; switch to more-[biomass]-productive crops
  4. Expanding cultivated area
     - Causes land use change ([I]LUC) emissions
- ILUC modeling estimates the mix of these effects

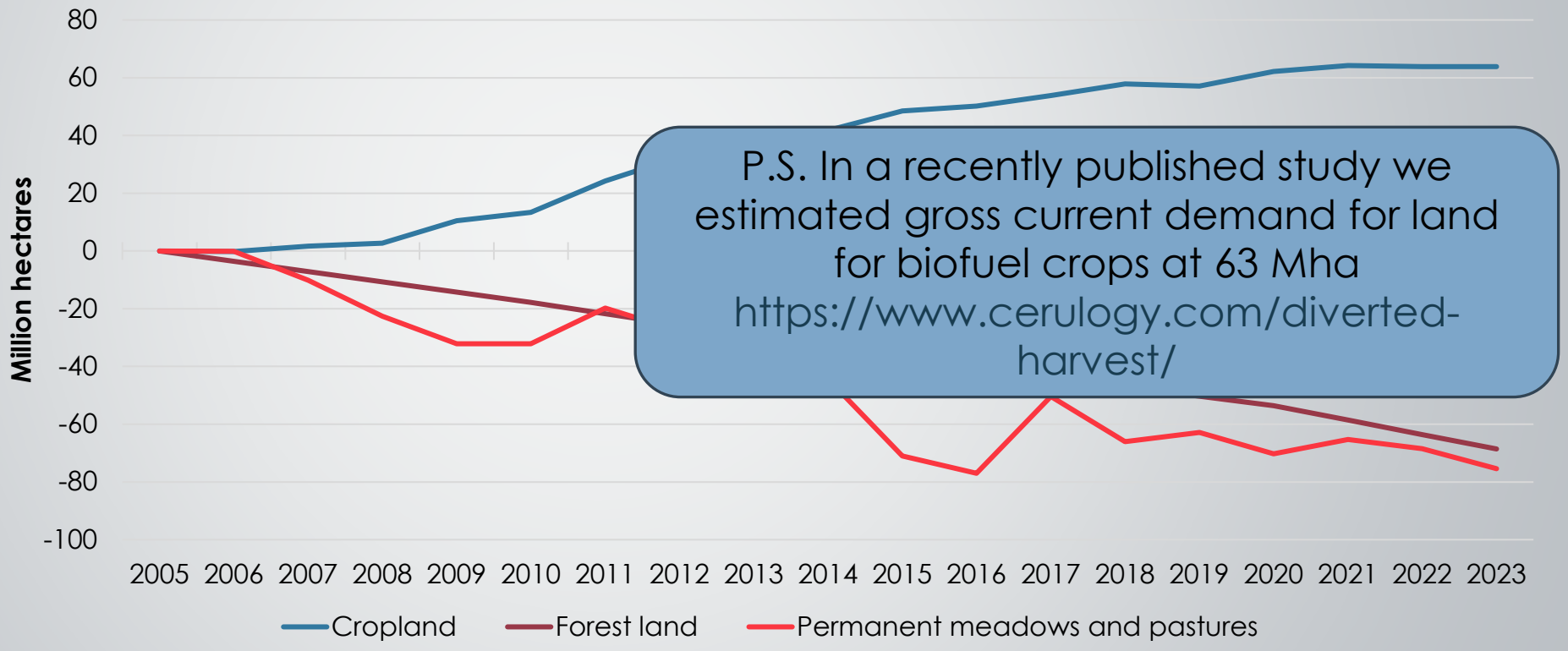
Agriculture, land use change and deforestation

- Globally, crop-agriculture is expanding

Crop	Harvested area 2008 (Mha)	Harvested area 2019 (Mha)	Total net expansion 2008-2019 (Mha)
Wheat	222	216	**-6**
Maize	159	184	**25**
Sugar cane	24	27	**3**
Sugar beet	4	5	**0**
Rapeseed	30	34	**4**
Oil palm	18	29	**11**
Soybeans	96	120	**24**
Sunflower	25	27	**2**
Total	***579***	***642***	***63***

https://iluc.guidehouse.com/images/reports/HILUC_Webinar_Phase_1_Slides.pdf

At global level, grassland and forestland is converted to cropland



P.S. In a recently published study we estimated gross current demand for land for biofuel crops at 63 Mha https://www.cerulogy.com/diverted-harvest/

https://www.fao.org/faostat/en/#data/RL

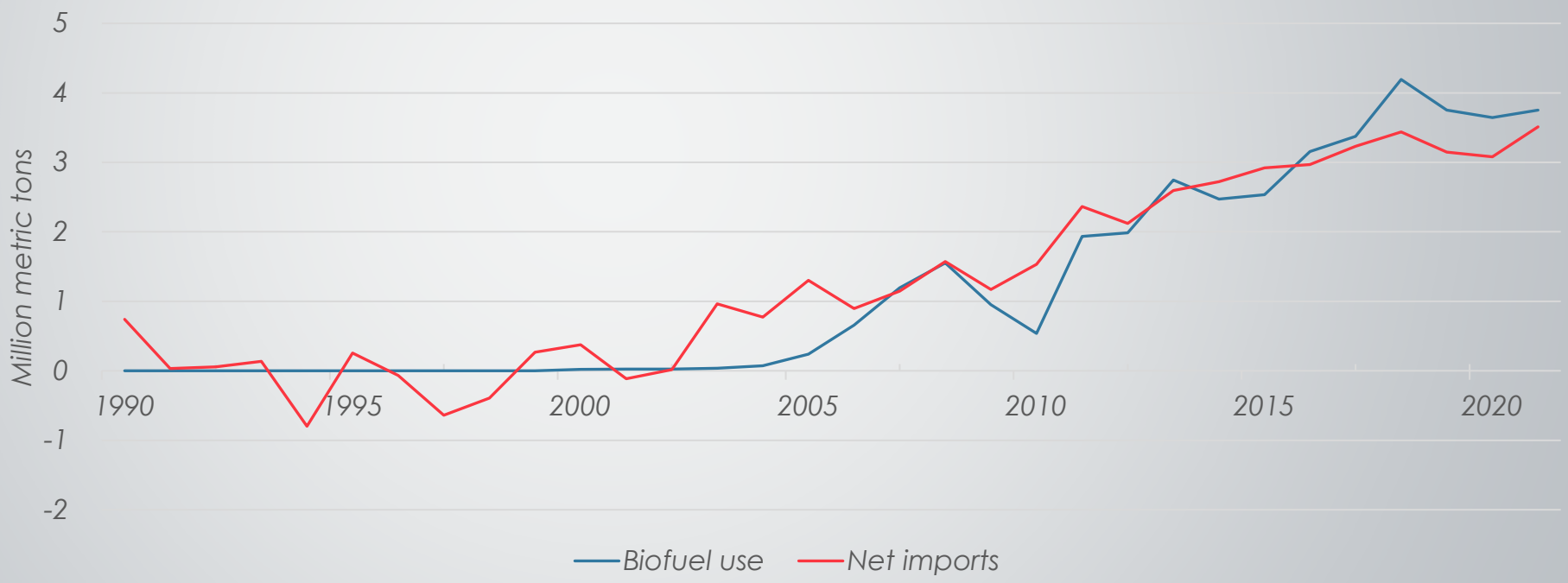
Forest is converted to cropland for biofuel crops

Crop	Increase of planted area (2008-2019) (Mha)	Expansion into forest area (Mha)	Expansion on peatland (Mha)	Share of expansion forest	Share of expansion peat
Wheat	10.7	0.3	0.0	3%	0%
Maize	36.9	2.5	0.0	7%	0%
Sugar cane	3.7	0.5	0.0	**14%**	0%
Sugar beet	0.7	0.0	0.0	0%	0%
Rapeseed	5.1	0.1	0.0	1%	0%
Oil, palm	11.0	3.4	1.1	**31%**	**10%**
Soybeans	25.3	2.4	0.0	**9%**	0%
Sunflower	6.4	0.1	0.0	2%	0%
Total	***100***	***9***	***1.1***	***9%***	***1%***

Preliminary results, https://iluc.guidehouse.com/images/reports/HILUC_Webinar_Phase_1_Slides.pdf

Biofuel mandates have implications for trade flows

- E.g. growth in virgin vegetable oil use for U.S. biofuels has been tracked by growth in net imports (the main increased imports are canola from Canada and palm oil from Southeast Asia)



OECD-FAO Agricultural Outlook 2021

Palm and soy – deforestation risk commodities

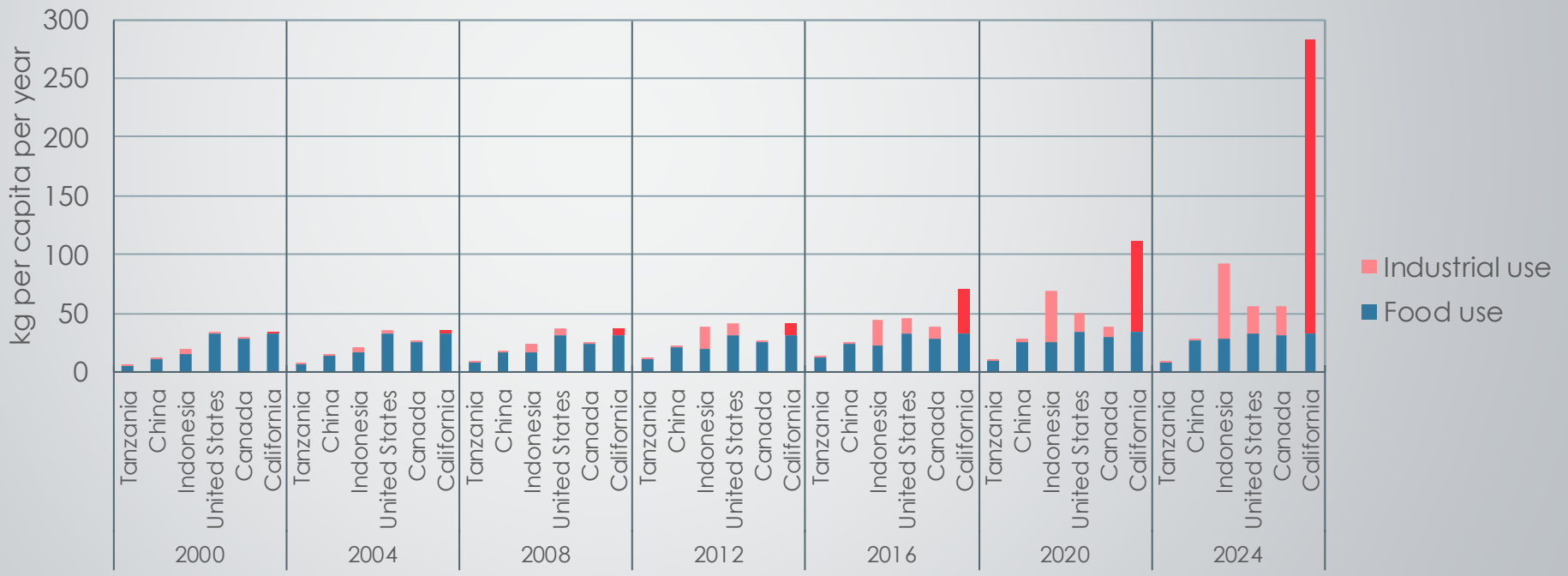
- Demand drives expansion, expansion causes deforestation
  - E.g., in Indonesia one study reports that: "Deforestation rates increase by 7% in places that experience a one standard deviation increase in local price exposure"*
- ILUC modeling tends to put higher emissions values on vegetable oils than grains/sugars
- A forthcoming UC study estimates that LUC in Indo-Malaysia alone adds 83.2 gCO_2e/MJ ILUC emission to all BBD†
- There is a convention of treating waste oils (UCO/yellow grease, animal fat) as having no indirect emissions
  - …but often they are displaced from other uses
  - Increased consumption of these oils in CA means increased demand for substitute oils elsewhere
  - These are not scalable resources
- California should consider what is its fair share of the global supply of veg oil feedstock

*Cisneros et al. 2021, https://www.sciencedirect.com/science/article/pii/S009506962100036X

† Chen et al. 2025, https://www.dropbox.com/scl/fi/06ug6d414ka6mq2cqryuy/Palm_Deforestation_full_Chen_Sexton_Smith_10_30.pdf

Per capita, California is the world's largest consumer of vegetable oil

- National values based on USDA PSD reporting
- California value is set to match U.S. until 2012, then set to LCFS data (incl. non-virgin oils) for industrial use



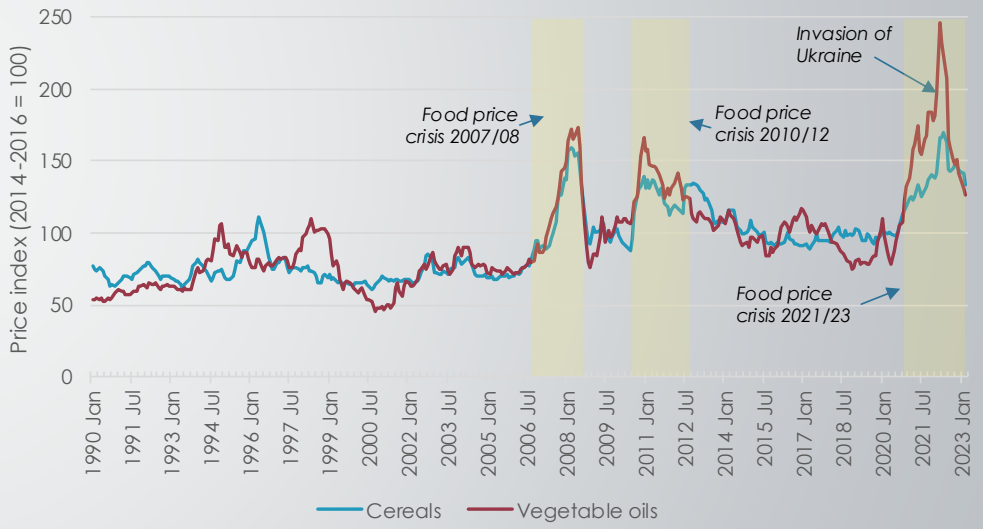
Teeing up some modeling issues in GTAP (Malins, Plevin and Edwards, 2021)

- Is the importance of cropland pasture exaggerated in GTAP?
  - "Cropland pasture estimates declined by nearly 79 percent in the 10 years between 2002 and 2012 after exhibiting relative stability for more than 50 years. **This decline is largely attributable to methodological changes in the collection of cropland pasture data** in USDA, NASS' Census of Agriculture, the data source for the cropland pasture category."
  - Reported cropland pasture area stabilized 2012 – 2017 with a return to a consistent survey
- Cropping intensity
  - Cropping intensity (e.g. adoption of double cropping) was introduced in 2017 as a strongly LUC-reducing effect
  - I argued the implementation was not well supported by evidence and was inappropriate
  - "Although there appeared to be a small increase in double cropping in the U.S. in the first years of the renewable fuel standard mandate, there has since been a significant decline. … For overall cropping intensity, which also factors in how often land is left fallow or crops fail, there has been no discernible U.S. trend for decades."

Cf. https://www.ers.usda.gov/data-products/major-land-uses/documentation#:~:text=Change%20in%20Cropland%20Pasture%20Methodology, https://ers.usda.gov/sites/default/files/_laserfiche/publications/109971/EIB-275.pdf?v=92437#page=78.04, https://tobin.yale.edu/sites/default/files/2024-12/Biofuels%2C%20Deforestation%2C%20and%20the%20GTAP%20Model_December%202024.pdf

Food versus fuel; high ILUC-risk

- The use of agricultural commodities for fuel also indirectly affects food markets
  - Increased food prices
  - Negative welfare impacts
- The EU has responded to ILUC and food concerns with a 'crop cap' and high ILUC-risk mechanism
  - Food-based fuels capped for road, excluded from aviation/maritime
  - Palm oil excluded from support (soy close to threshold)



https://www.cerulogy.com/biofuels-and-food-markets/

Closing thoughts: ILUC in policy

- Fifteen years ago California introduced ILUC factors to reduce LUC impacts of LCFS
  - Commitment to follow the evidence
  - Choice of GTAP informed by transparency concerns (source code available)
  - May have hoped for harmonization and consensus
- The ILUC results have been contested
  - Some stakeholders call for adoption of lower values
  - Some stakeholders (e.g. me) have queried the robustness of the modeling
  - Practical transparency limited by the complexity of the tool and evidence
- A larger contribution of cellulosic fuels was anticipated
  - Context of RFS cellulosic mandate
  - Vision of LCFS as investment driver
  - ILUC factors would skew value away from first generation biofuels
- Cellulosic fuel production has not materialised
  - Investment drivers in the U.S. have had challenges/flaws
  - RD and secondary have won out over cellulosic investment
- Other jurisdictions (EU, Canada) have used caps and/or feedstock restrictions
- Growth for aviation and maritime means that globally scalable solutions are needed

Thanks!

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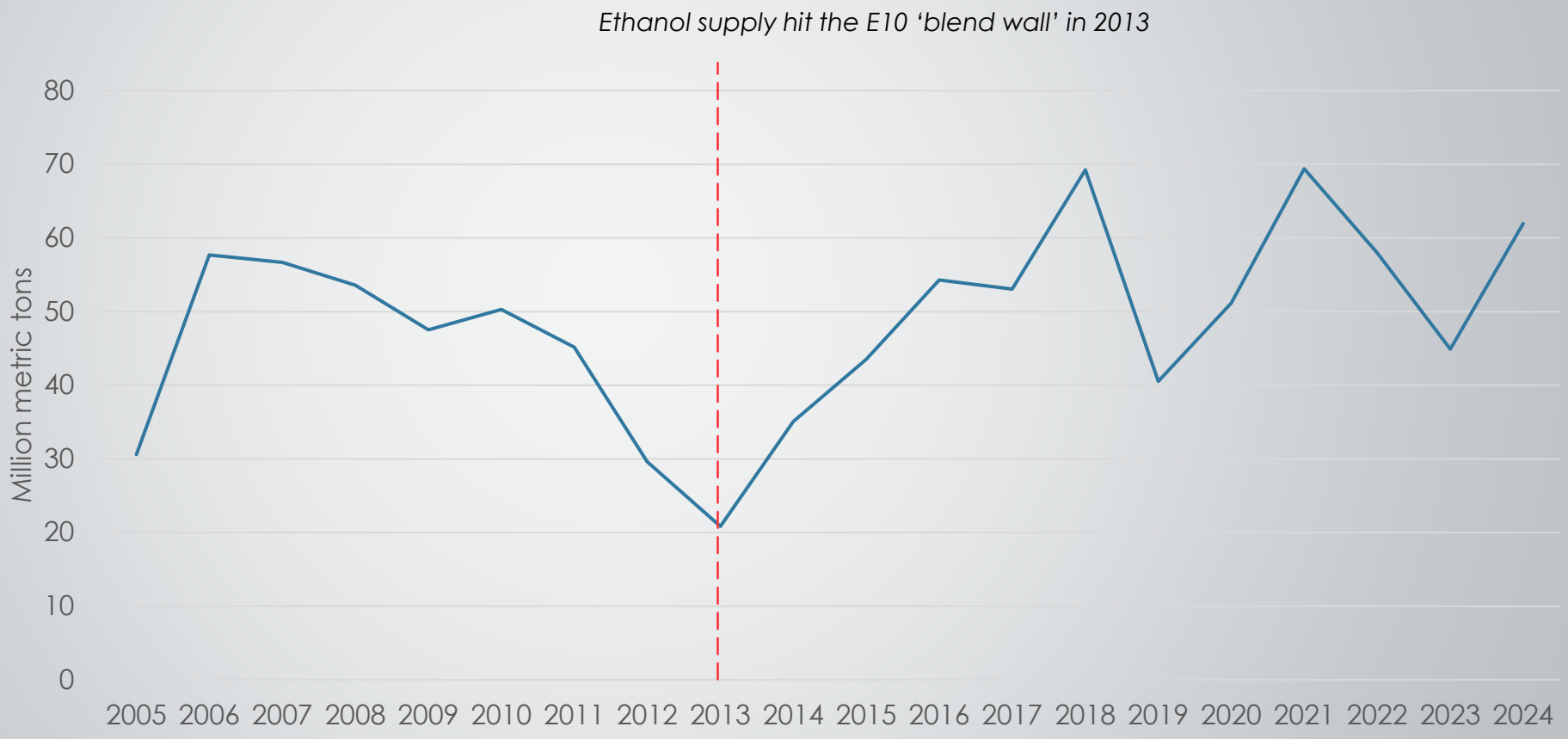
Additional data

Corn net exports, U.S.



https://comtradeplus.un.org/TradeFlow

Palm and deforestation in Indonesia

- Low deforestation post-2016 seems to coincide with rapid oil palm area increase in FAOstat
- But it takes time to plant plus ~ four years for oil palm to reach harvest age – the area boom in 2017 corresponds to the high deforestation in 2012/2013