

CRC LCA workshop

# A Review of Trends During the Biofuel Ramp Up

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Daniel Tanner (2017 EPA-OTAQ Summer Intern) for extensive data gathering and database development

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**DISCLAIMER:** The views expressed are those of the author and do not represent official policy of US EPA



# Purpose

- Review trends during the recent period of U.S. biofuel expansion, from roughly 2000 to the present.
- The general focus is on land use change and its drivers, as that has been recognized as a key factor in the lifecycle GHG emissions associated with biofuels.
- Reviewing trends does not allow us to draw conclusions about how much of the observed impacts are attributable to biofuels.
- The goal is to provide perspective, setting the stage for further discussion.

# Disclaimers and Qualifiers

- **The views expressed are those of the author and do not represent official policy of U.S. EPA**
- This presentation relies on publically available information, primarily data published by:
  - The United Nations Food and Agriculture Organization (FAO)
  - The United States Department of Agriculture (USDA)
  - The U.S. Energy Information Agency (EIA)
- Data sources were chosen in order to depict overall U.S. and global trends
- There are many other sources of data and information
- This presentation is not intended to identify the best or most accurate data sources

# Overview

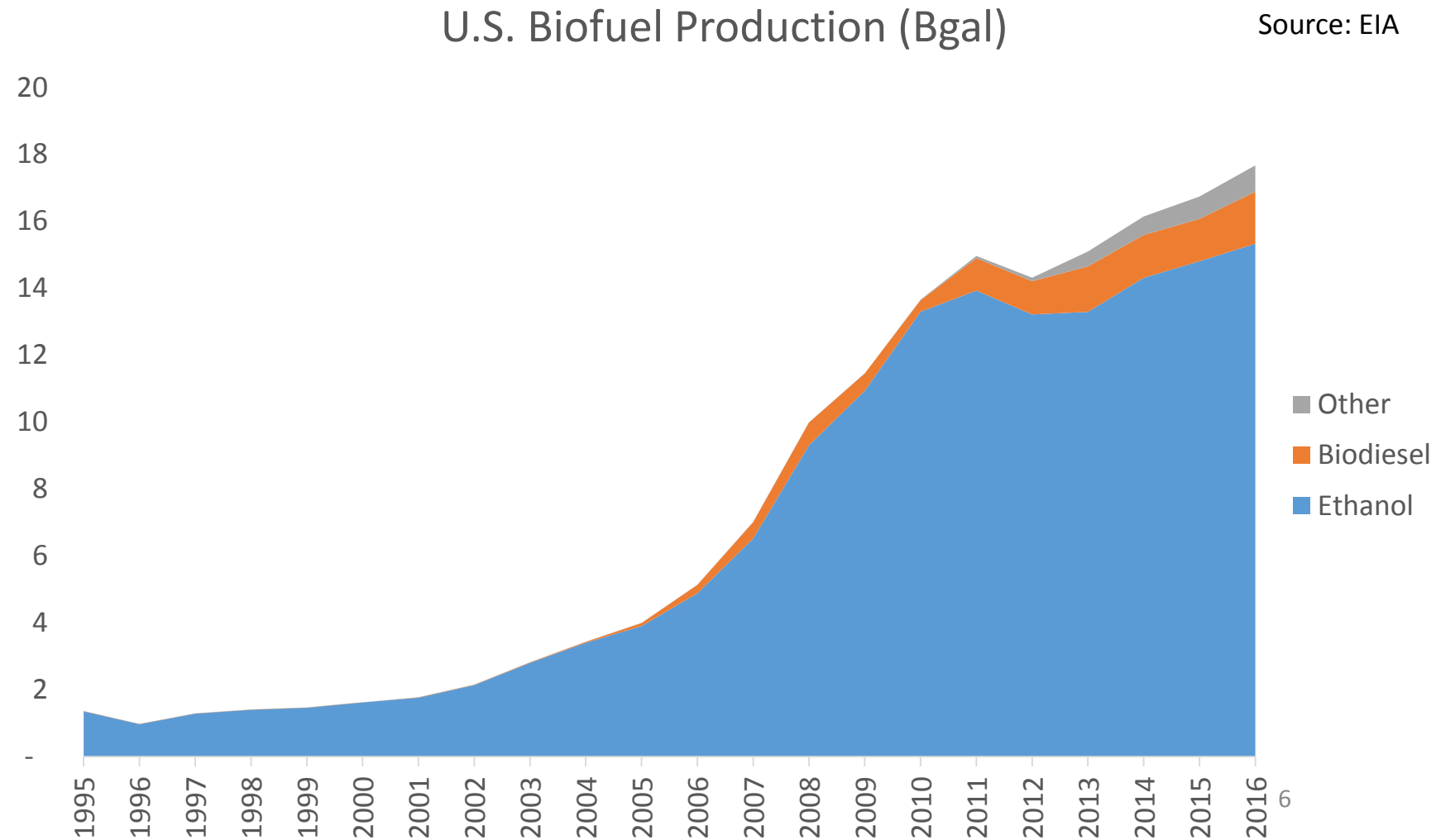
- United States Trends
  - Biofuel production
  - Agricultural trends
  - Land use change
- Global trends
  - Biofuel production
  - Agricultural trends
  - Land use change
- Discussion

A photograph of a cornfield with green stalks and developing ears. The image is darkened to serve as a background for the title text.

# U.S. Trends

# Biofuel production ramped up significantly

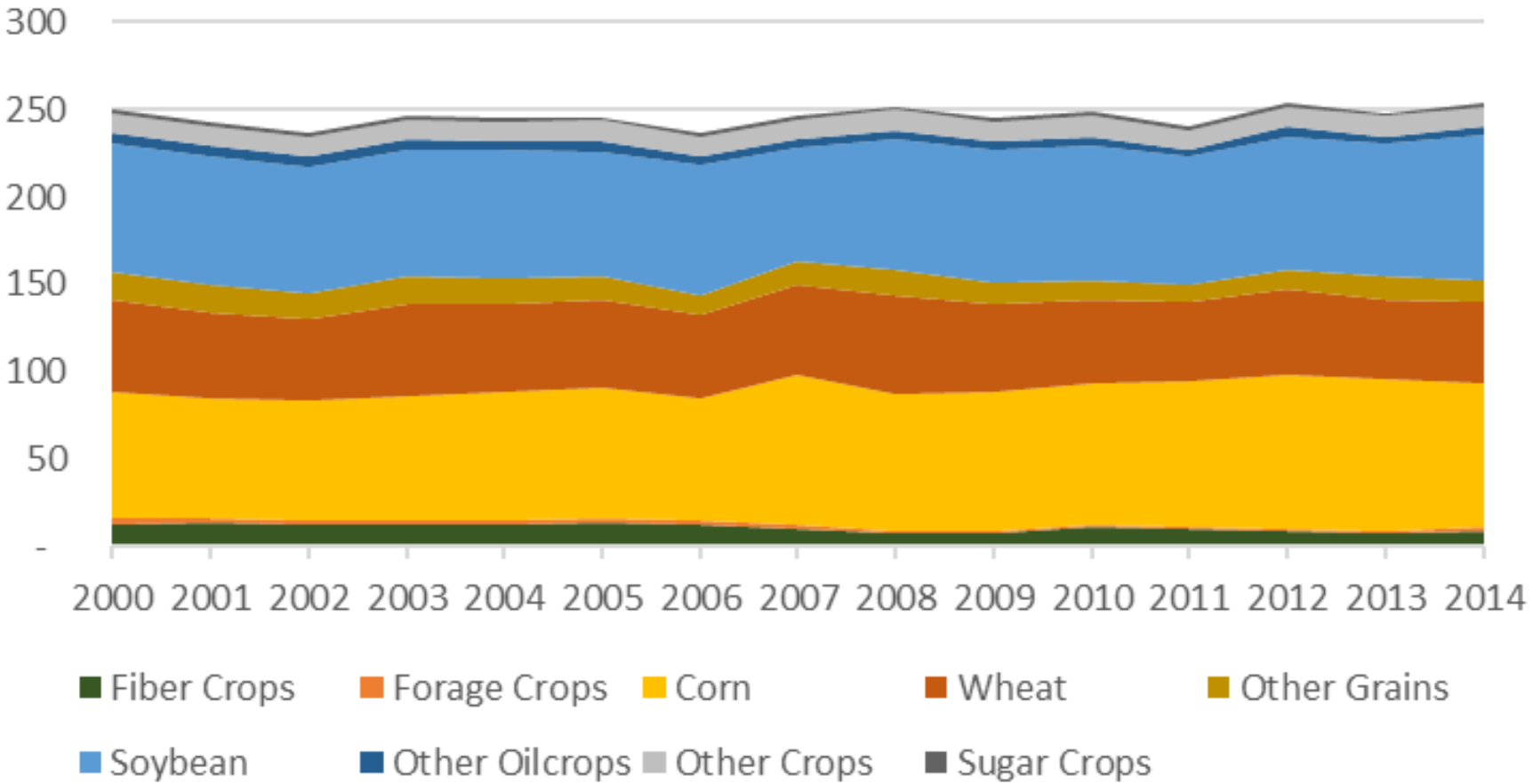
- On average, production increased 1 Bgal per year from 2000-16
- Ethanol accounted for almost 90% of biofuel production in 2016
- Corn starch was the dominant ethanol feedstock
- Soybean oil accounted for about half of biodiesel production
- Biofuels are still a small component of overall transportation fuel production (7% in 2016)



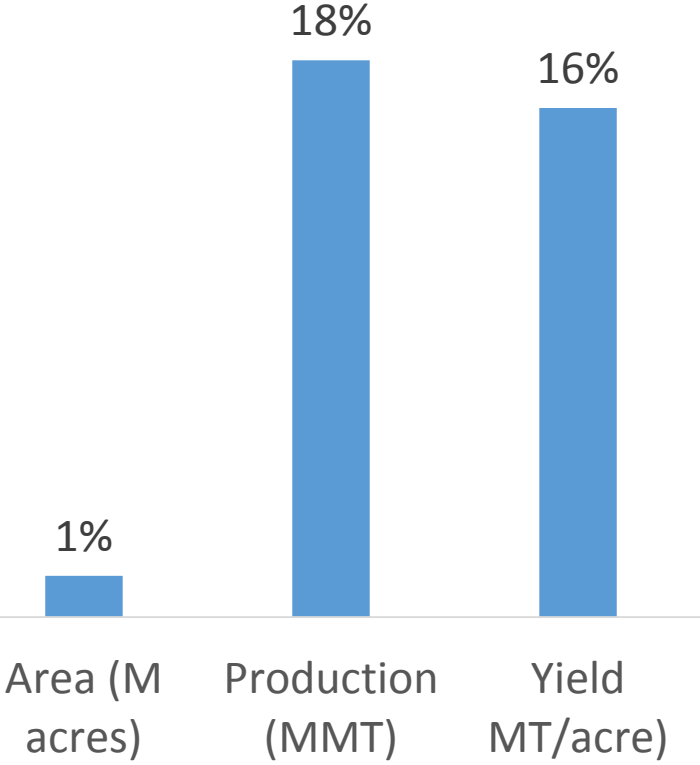
# Harvested area expanded slightly and intensified

Source: FAO

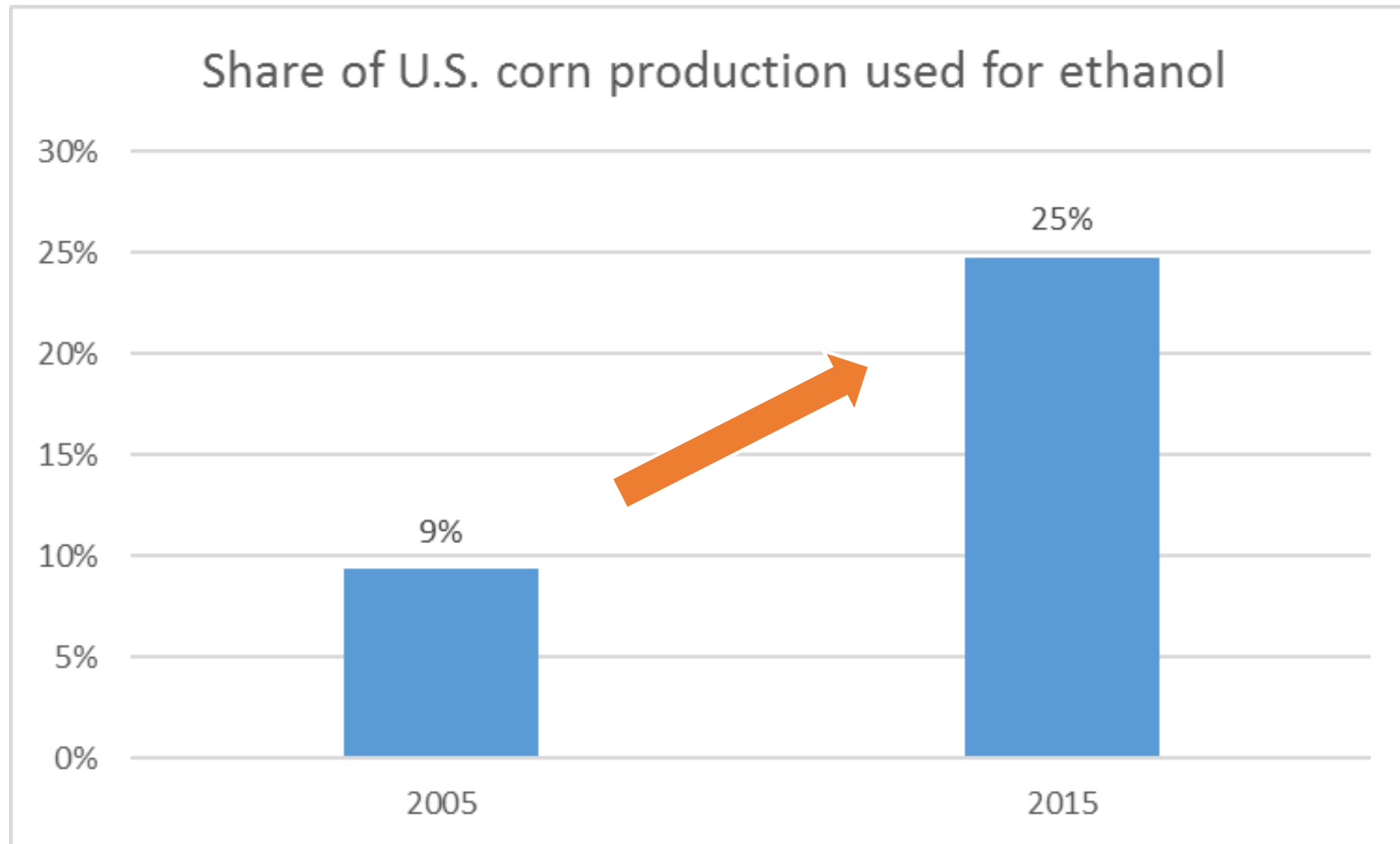
U.S. Harvested Area (M acres)



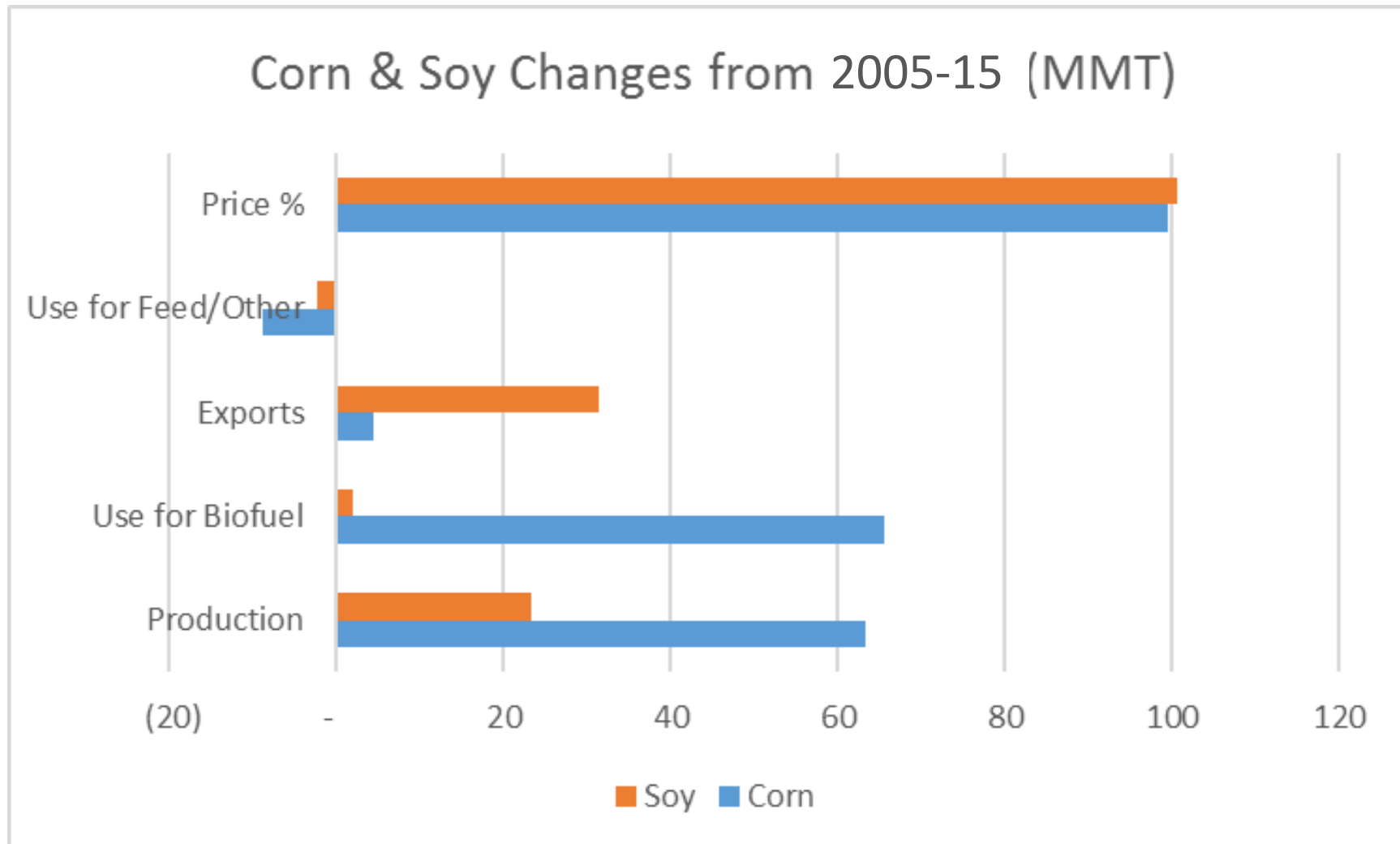
Percent Change from 2000-14



Quiz Time: Raise your hand if you think U.S. corn exports **INCREASED** during this period



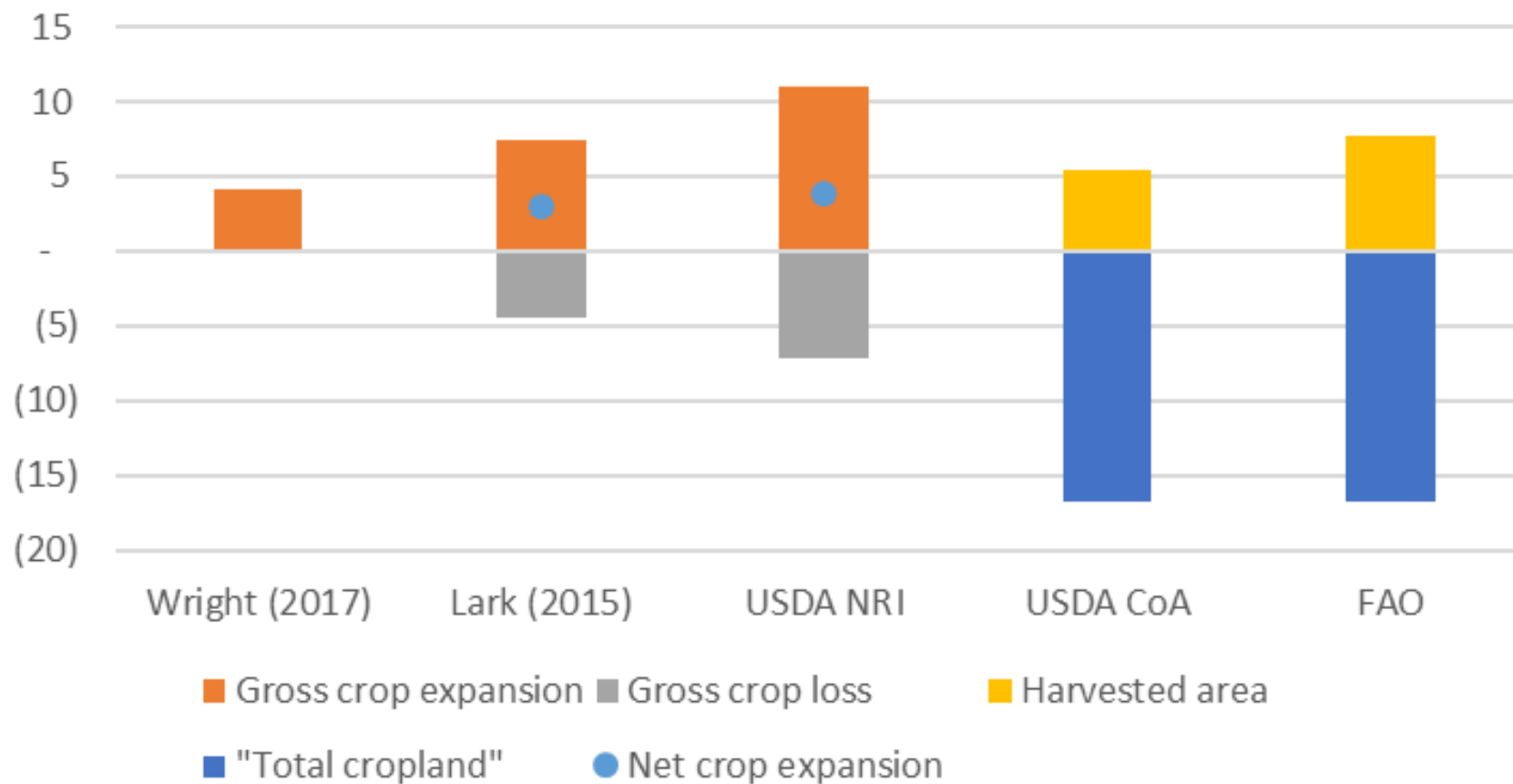
# Corn and soy production and exports increased, use for feed decreased



Sources:  
USDA-ERS  
[www.farmdoc.illinois.edu/manage/usp\\_ricehistory/us\\_price\\_history.html](http://www.farmdoc.illinois.edu/manage/usp_ricehistory/us_price_history.html)

# Net crop expansion from 2007-12 of about 4-5 M acres

U.S. Land Use Change 2007-12 (M acres)



- Lark is for 2008-12
- Wright is only within 100 mi of biorefinery
- CoA "Total cropland" = harvested + potential + other, i.e., a measure of land that could potentially be used as cropland
- FAO "Total cropland" = Arable Land & Permanent Crops
- *Are FAO data appropriate for measuring intensification?*

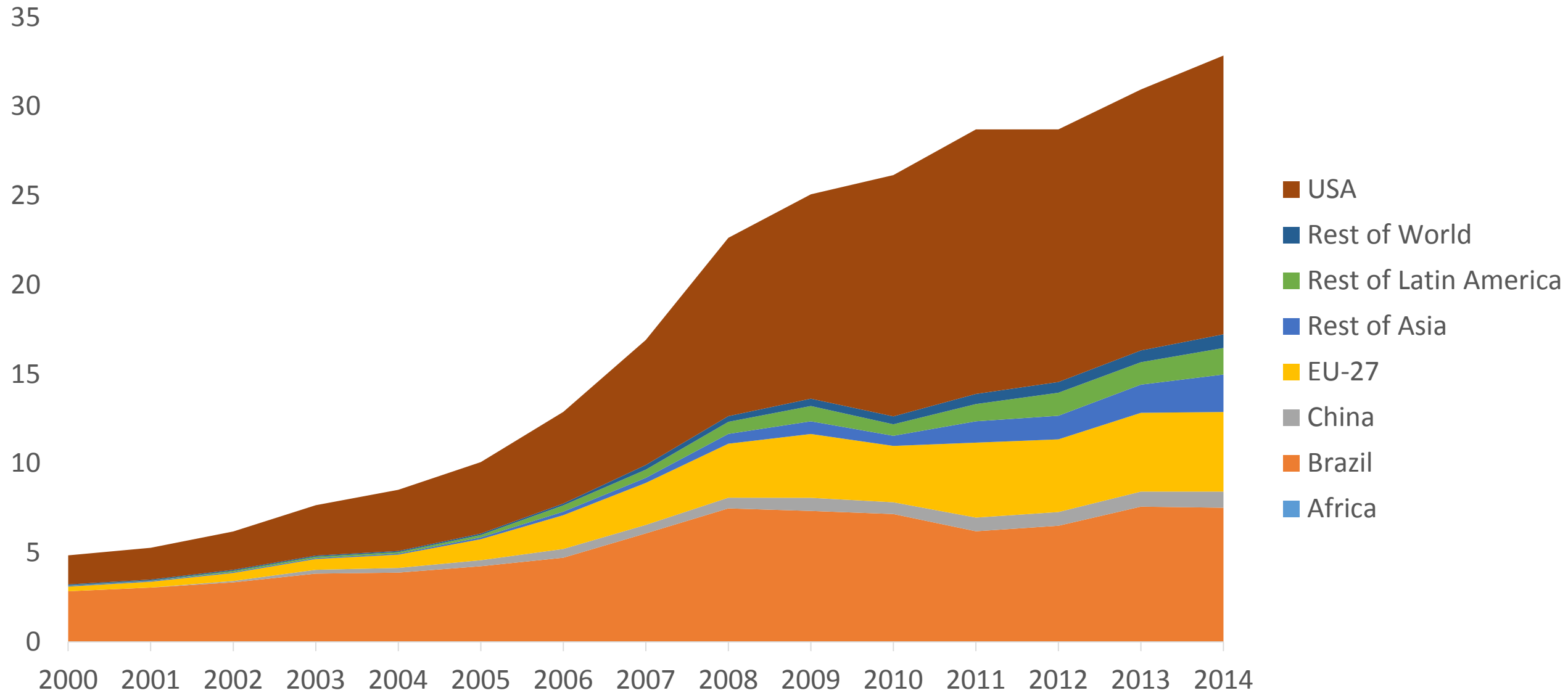
# Summary of U.S. Trends

- Over the past 16 years biofuel production increased by about one Bgal per year, mostly corn ethanol
- According to FAO data, from 2000-14 harvested area expanded slightly (1%) and intensified (production up 18%)
- Corn production increased by about the same amount as corn used for ethanol, and corn exports were steady
- Soybean production and exports increased over the same period
- From 2007-12, cropland expanded during the biofuel ramp up, mainly coming from grasslands and CRP
  - Double cropping did not significantly increase (Borchers et al. 2014)
- How much of these trends are attributable to biofuels is unresolved

A photograph of a lush green sugarcane field under a clear blue sky. The stalks are tall and dense, filling the frame. The text 'Global Trends' is overlaid in white, centered horizontally.

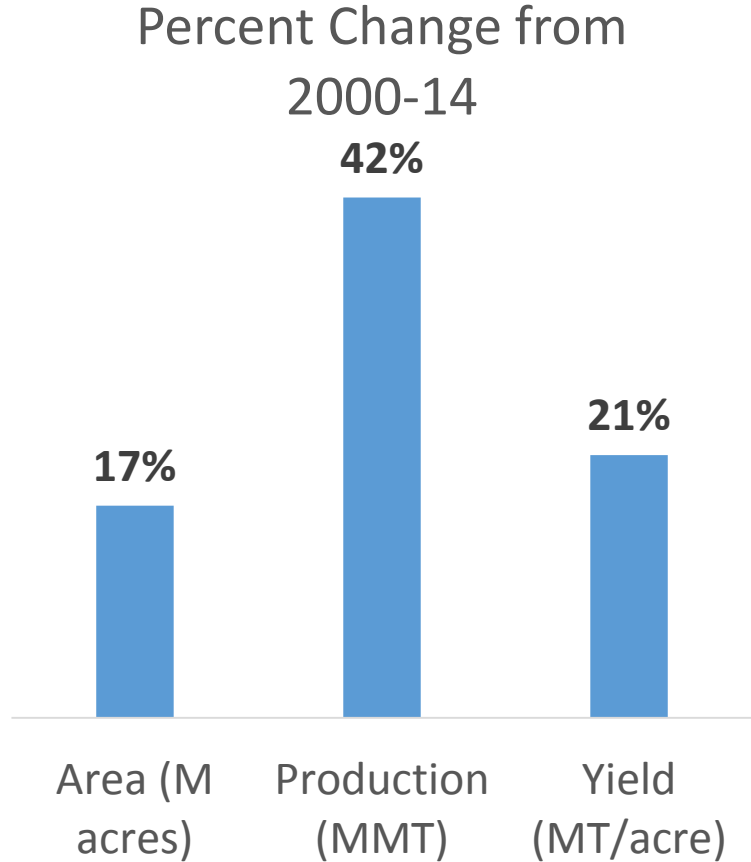
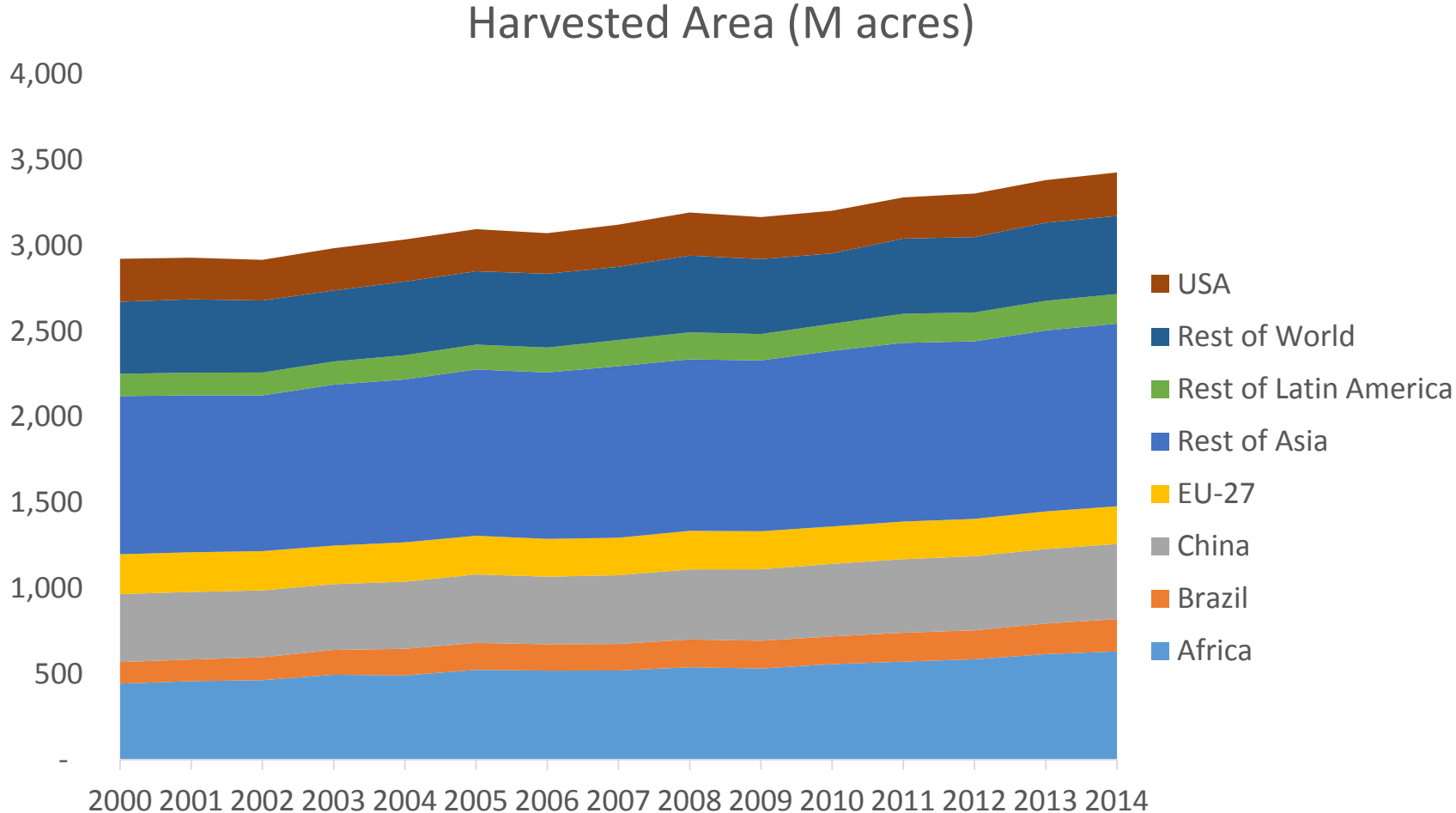
# Global Trends

## Ethanol and Biodiesel Production (Bgal)



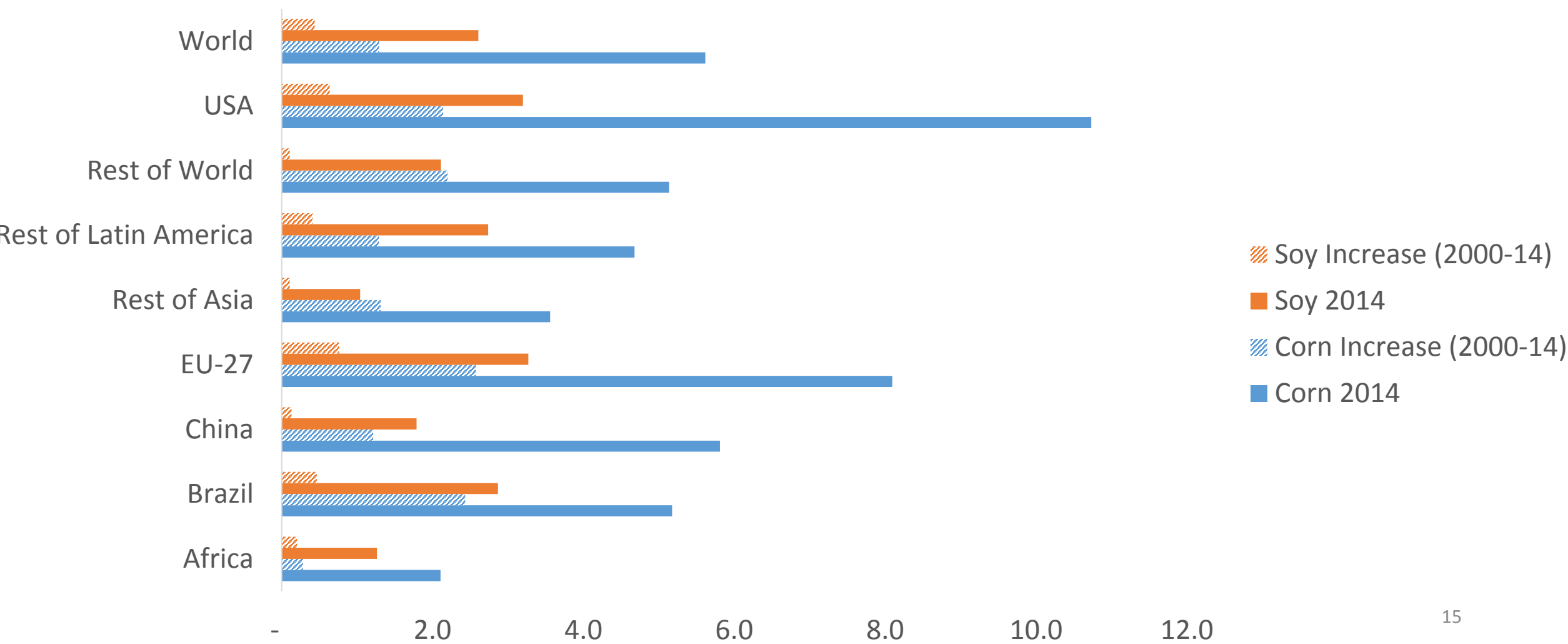
Production increased by 28 Bgal. Ethanol accounted for 80% of biofuel production in 2014.  
U.S., Brazil and EU were the dominant producers.

# Harvested areas expanded and intensified



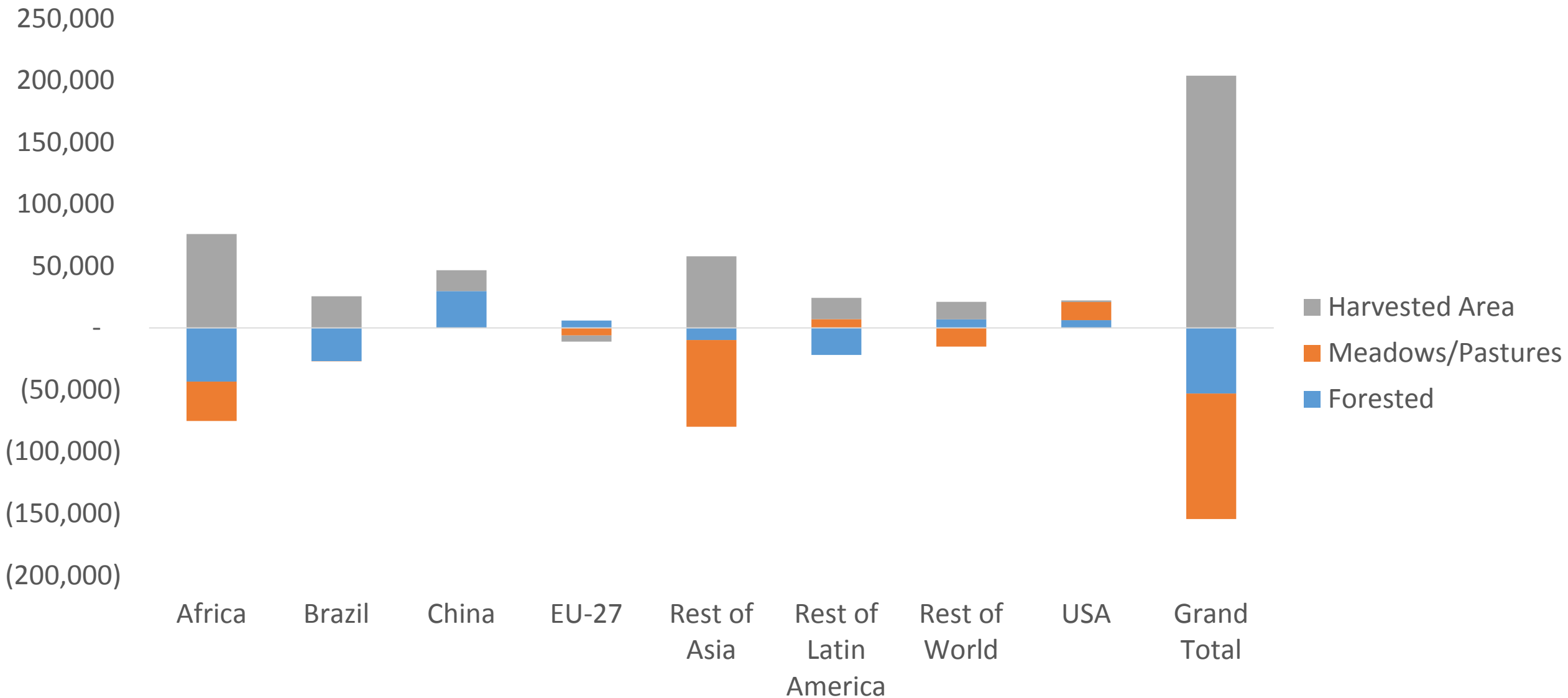
# Yield gains varied by region and crop

Corn and Soy Yields by Region (MT/ha)



## Land Changes from 2000-2014 by Region (1000 ha)

Source: FAO



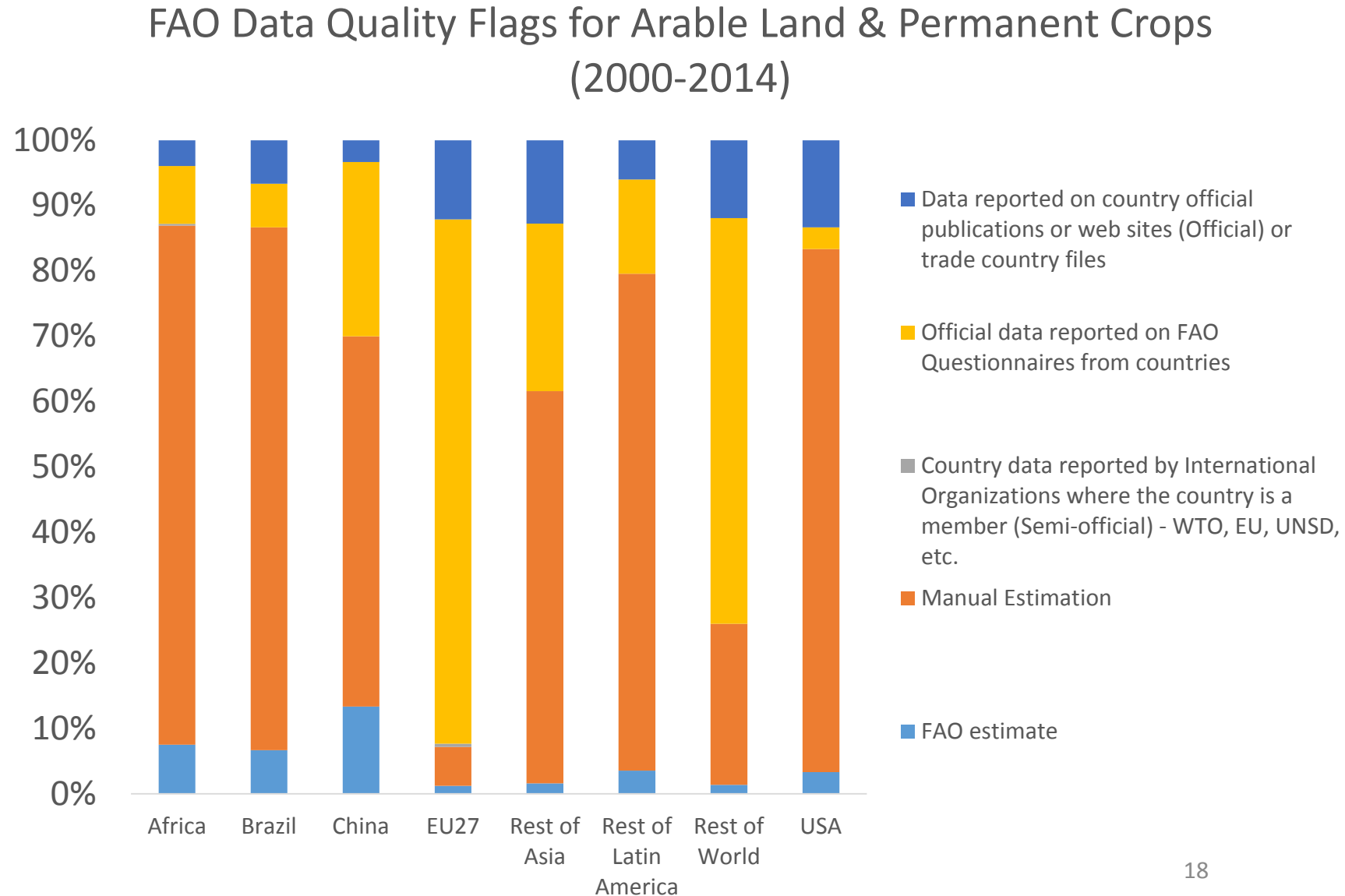
Harvested area increased, while forested and meadow/pasture area decreased.  
Forest loss was greatest in Africa, Brazil and Rest of Latin America

# Summary of Global Trends

- Biofuel production increased by 28 Bgal, mostly ethanol
- Based on FAO, Crop production increased 40% and harvested area increased 17% (500 M acres – double US area)
- Based on FAO, forested area declined by 131 million acres, or about 1%
- Population increased 16% and GDP per capita almost doubled
- With increased population, per capita income and biofuel production during this time period, crop extensification would likely have been larger without concurrent intensification

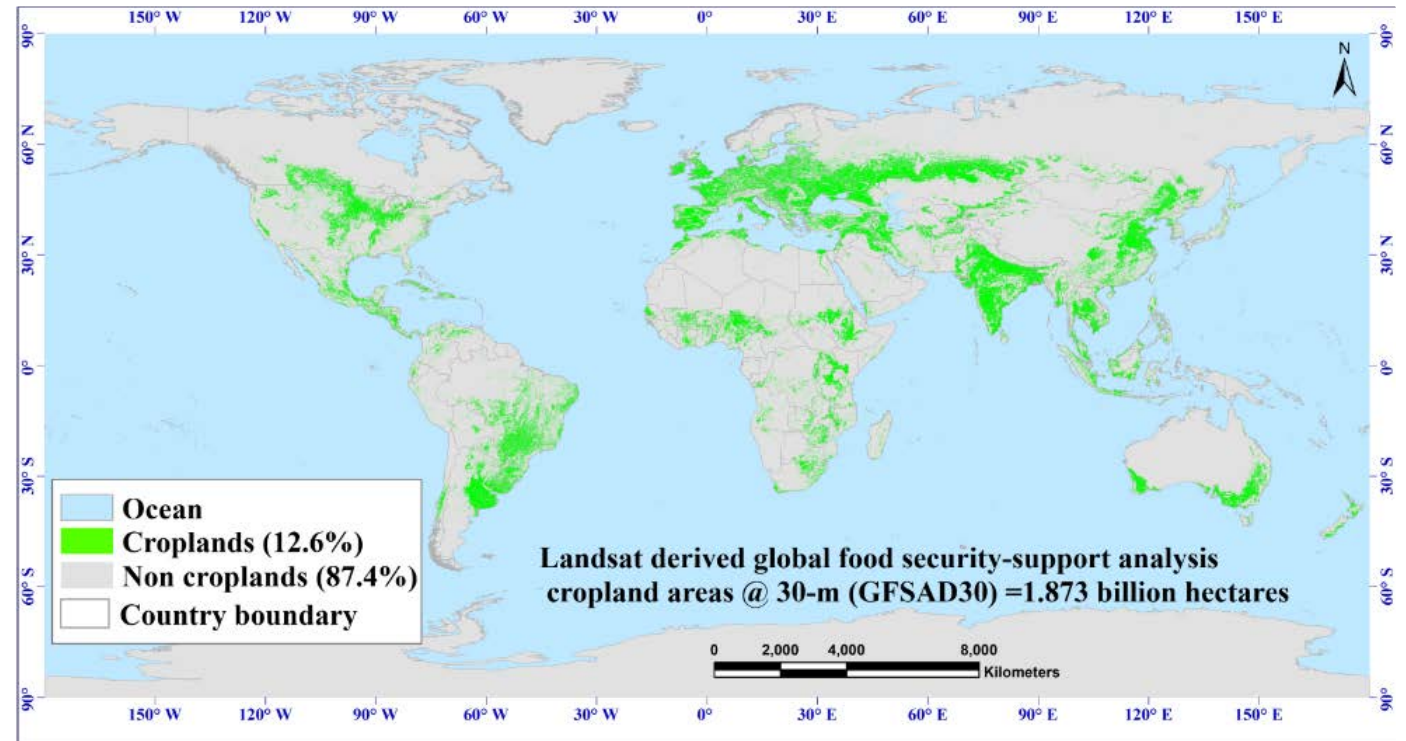
# FAO Data Quality

- From FAO meta-data:
  - Overall accuracy is not assessed. IPCC defines FAOSTAT statistics as reasonably accurate.
  - Geographical comparability maybe limited due to differences between countries in methods, definitions and coverage.
  - Time comparability may be limited for some countries due to changes in their methods, definitions and coverage.
  - <http://www.fao.org/faostat/en/#data/RL>



# Key data need: global planted area

- FAO reports arable land and harvested area, but not planted area.
- Planted area is key for measuring land use change and intensification/extensification.
- USGS Global Food-Security Support Analysis Data at 30 m (GFSAD30) is a NASA-funded project with plans to release planted crop maps, with annual time step
- See: <https://web.croplands.org>



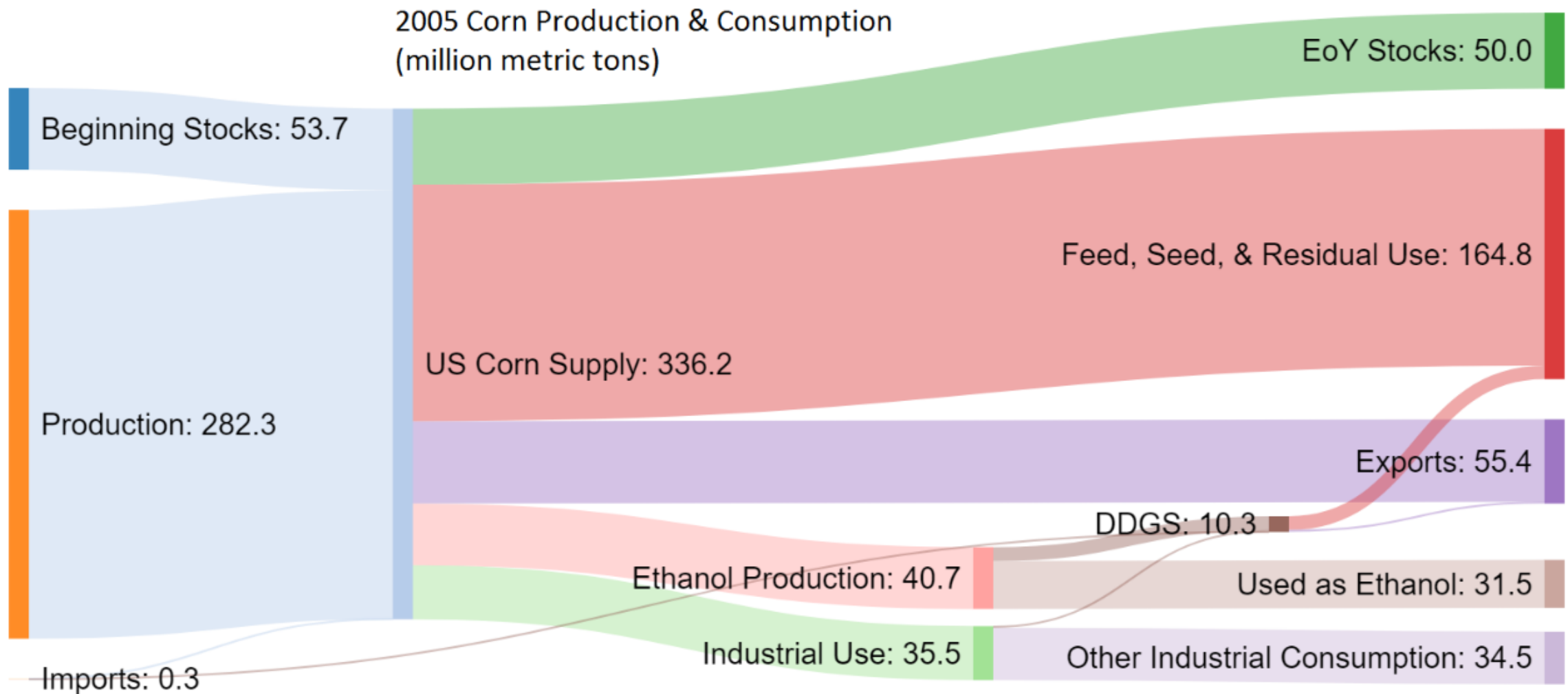
# Discussion

- Do we have general agreement on trends during the biofuel ramp up?
  - We should all be able to agree there was intensification, but determining the details on how this occurred requires additional study
- How do we leverage historical data for LCA modeling?
  - Many models base key parameter values (e.g., elasticities) on literature review and expert judgment
  - Can more of these parameters be determined through calibration on historical data?
- Can we quantitatively attribute observed impacts to biofuels? What data and methods are required?
- Of course, historical data will always have limited utility when our goal is to estimate future impacts.

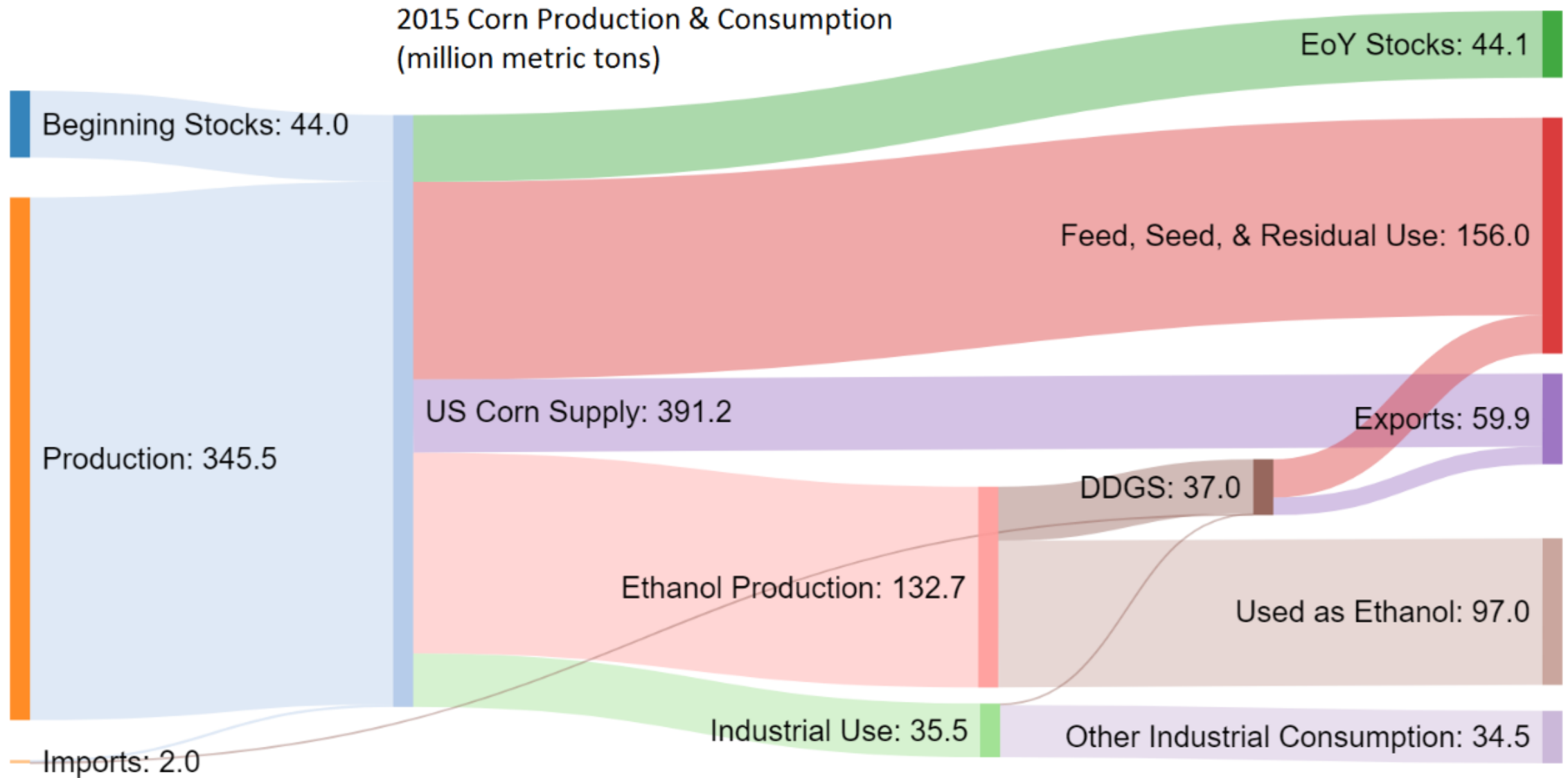
# References

- FAO. <http://www.fao.org/faostat/en/#data>, accessed summer 2017
- USDA-ERS. (2017). Feed Grains: Yearbook Tables: <https://www.ers.usda.gov/data-products/feed-grains-database/feed-grains-yearbook-tables/>
- EIA. (2017). U.S. Energy Information Agency. Open Data: <https://www.eia.gov/opendata/qb.php?category=711307>
- USDA CoA. (2014). 2012 Census of Agriculture: <https://www.agcensus.usda.gov/Publications/2012/>
- USDA NRI. (2015). 2012 Natural Resources Inventory. [https://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcseprd396218.pdf](https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcseprd396218.pdf)
- Lark (2015). Cropland expansion outpaces agricultural and biofuel policies in the United States. *Environ. Res. Lett.* 10 044003 [doi:10.1088/1748-9326/10/4/044003](https://doi.org/10.1088/1748-9326/10/4/044003)
- Wright (2017). Recent grassland losses are concentrated around US ethanol refineries. *Environmental Research Letters* 12(4). <http://iopscience.iop.org/article/10.1088/1748-9326/aa6446/meta>



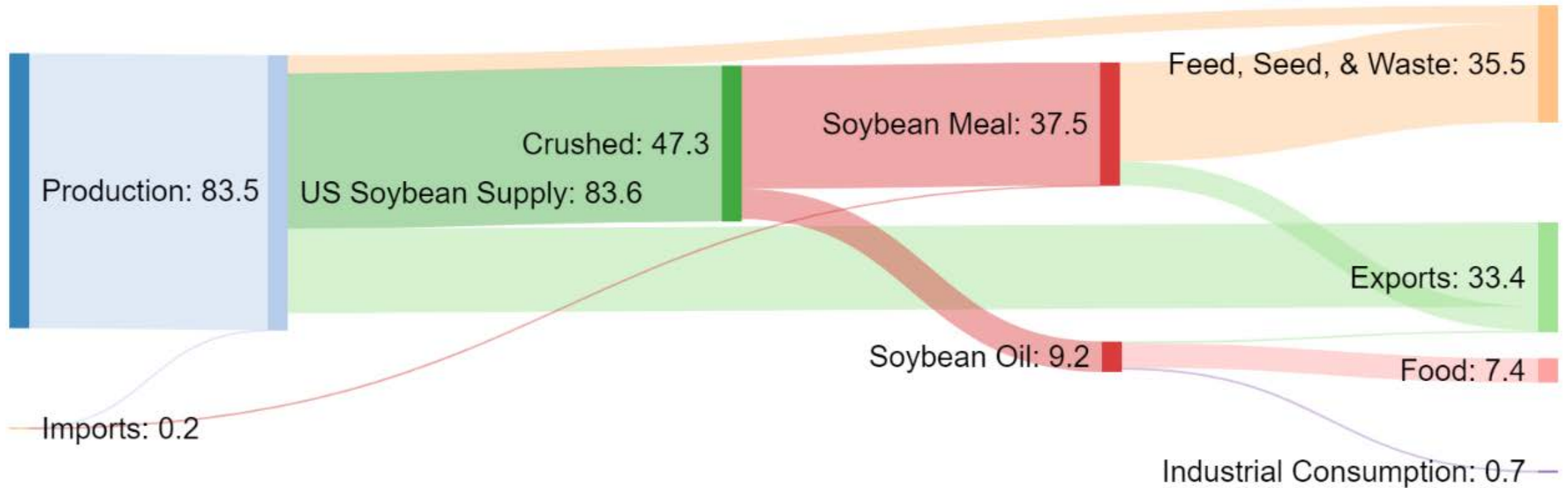


In 2005, about 9% of the corn supply was used for ethanol.



In 2015, 25% of the corn supply was use for ethanol.

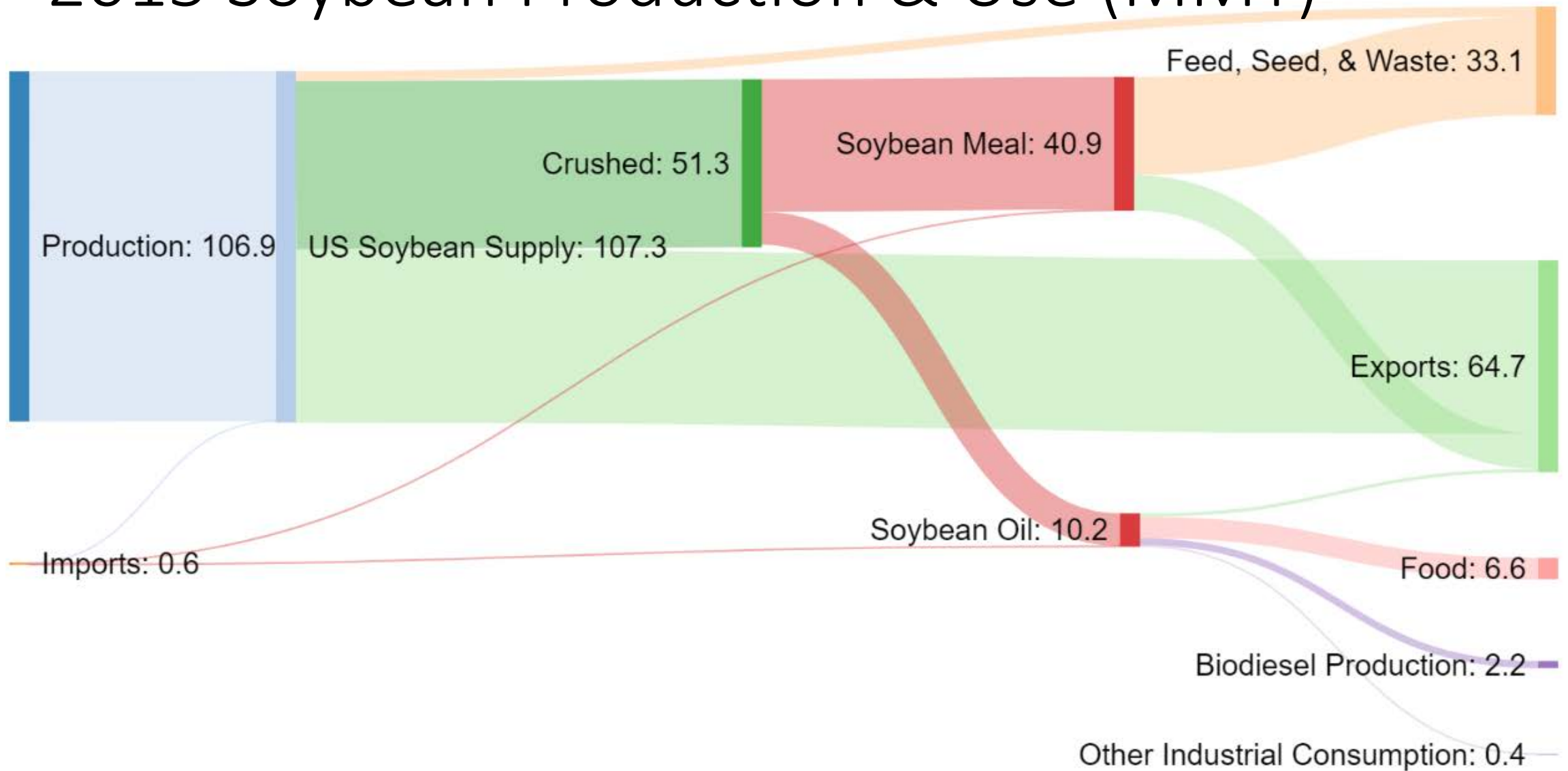
# 2005 Soybean Production & Use (MMT)



Source: USDA-ERS 2017  
<http://sankeymatic.com/build/>

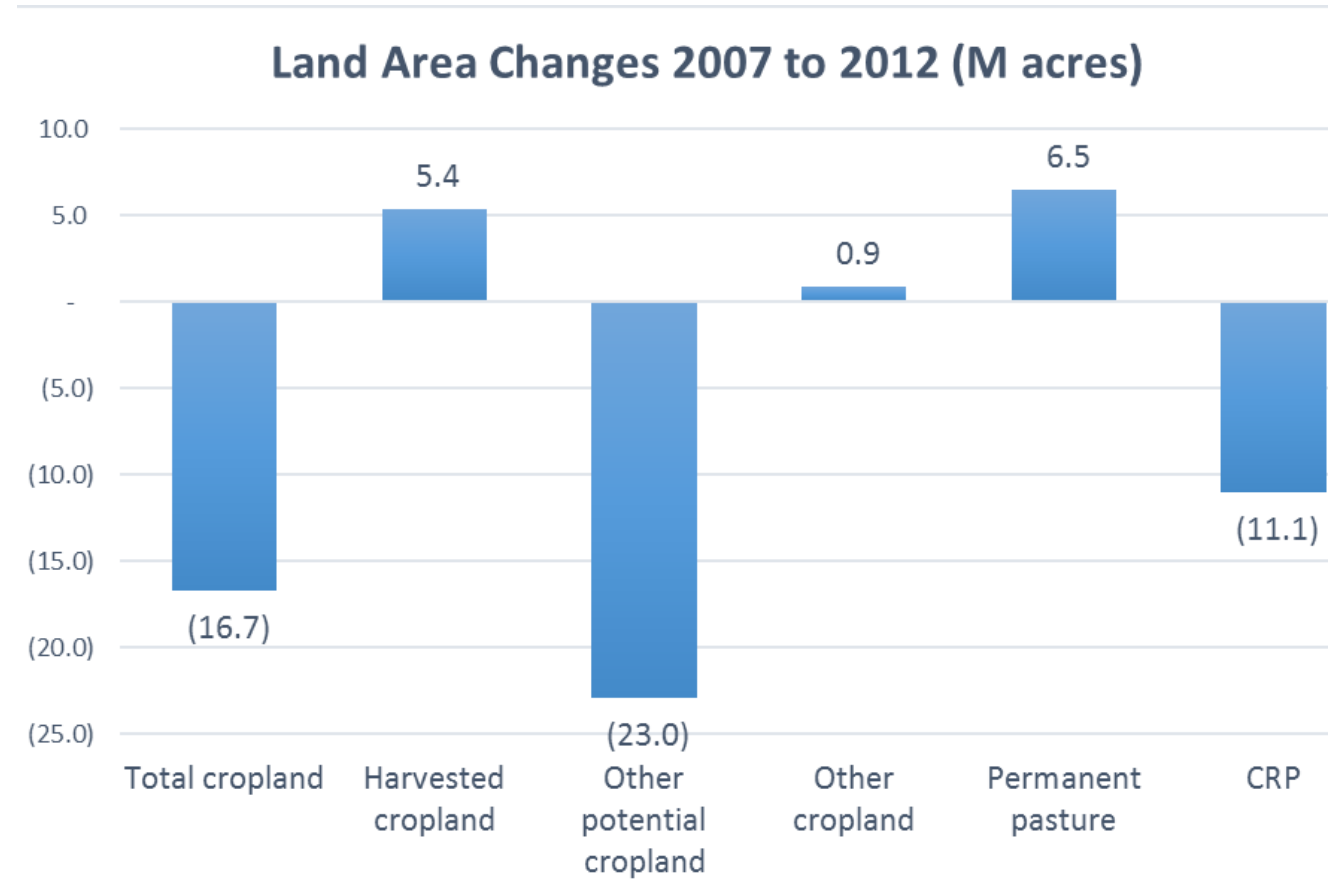
Biodiesel use is part of the tiny “Industrial Consumption” flow

# 2015 Soybean Production & Use (MMT)



# 2012 USDA Census of Agriculture (CoA, 2014)

- Detailed surveys sent to all U.S. farms, with extensive QA/QC
- Total cropland = harvested + potential + other
- Total cropland is a measure of land that could potentially be used as cropland
- 2017 CoA results coming in Feb. 2019



# 2012 USDA National Resources Inventory (NRI, 2015)

- Methods
  - ~400,000 sample locations, >1M sample points
  - Identifies land use change
- NRI cropland is land that was actually cropped

