

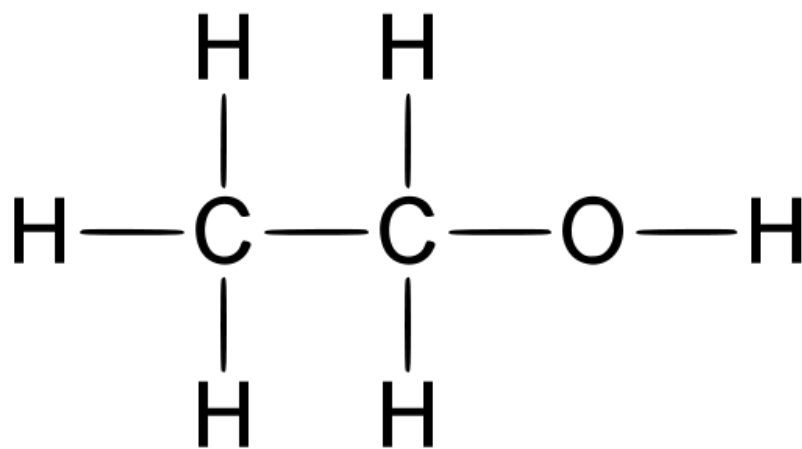
Ethanol

- Kenneth M. Klemow, Ph.D.
- EGY 105 – Energy in Our World
- Wilkes University



Ethanol

- Relatively small organic molecule
 - $\text{C}_2\text{H}_5\text{OH}$
 - Liquid at normal temperatures and pressures



Producing ethanol

- Produced by processing sugars
 - Anaerobic conditions
 - Fermentation
 - Distillation
- Distillation requires heating fluid, which requires energy



<http://www.loe.org/thisweek/050506ethanol.jpg>

Ethanol can be used to power internal combustion engines

- Most gasoline engines will run on ethanol, though less efficiently
- Easily run on blends (E20 is common)
- E85 used by Flex-Fuel vehicles, with sensors that detect alcohol content.



Ethanol is derived from three starting materials



Simple sugars (beets, cane)



Starch (grains, tubers)



Cellulose (leaves, stems)

Where does ethanol come from?

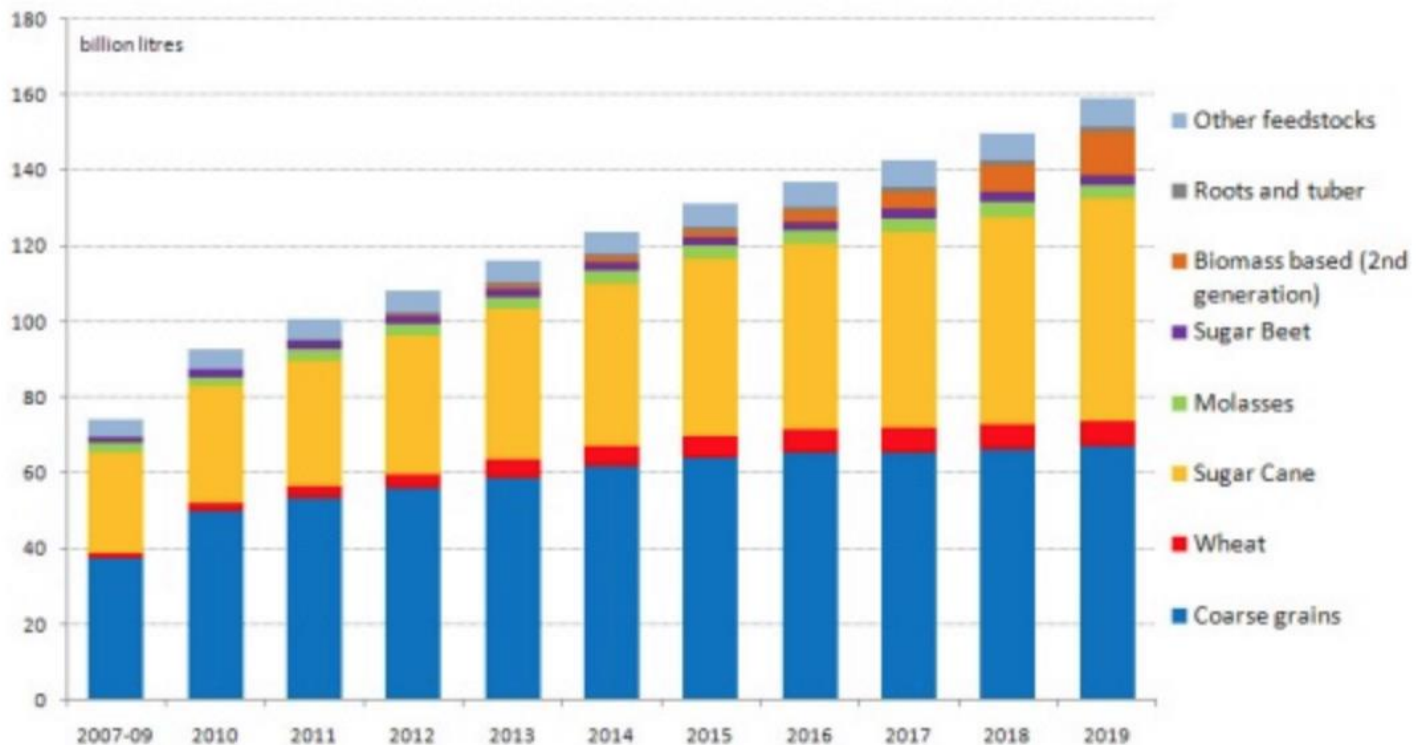
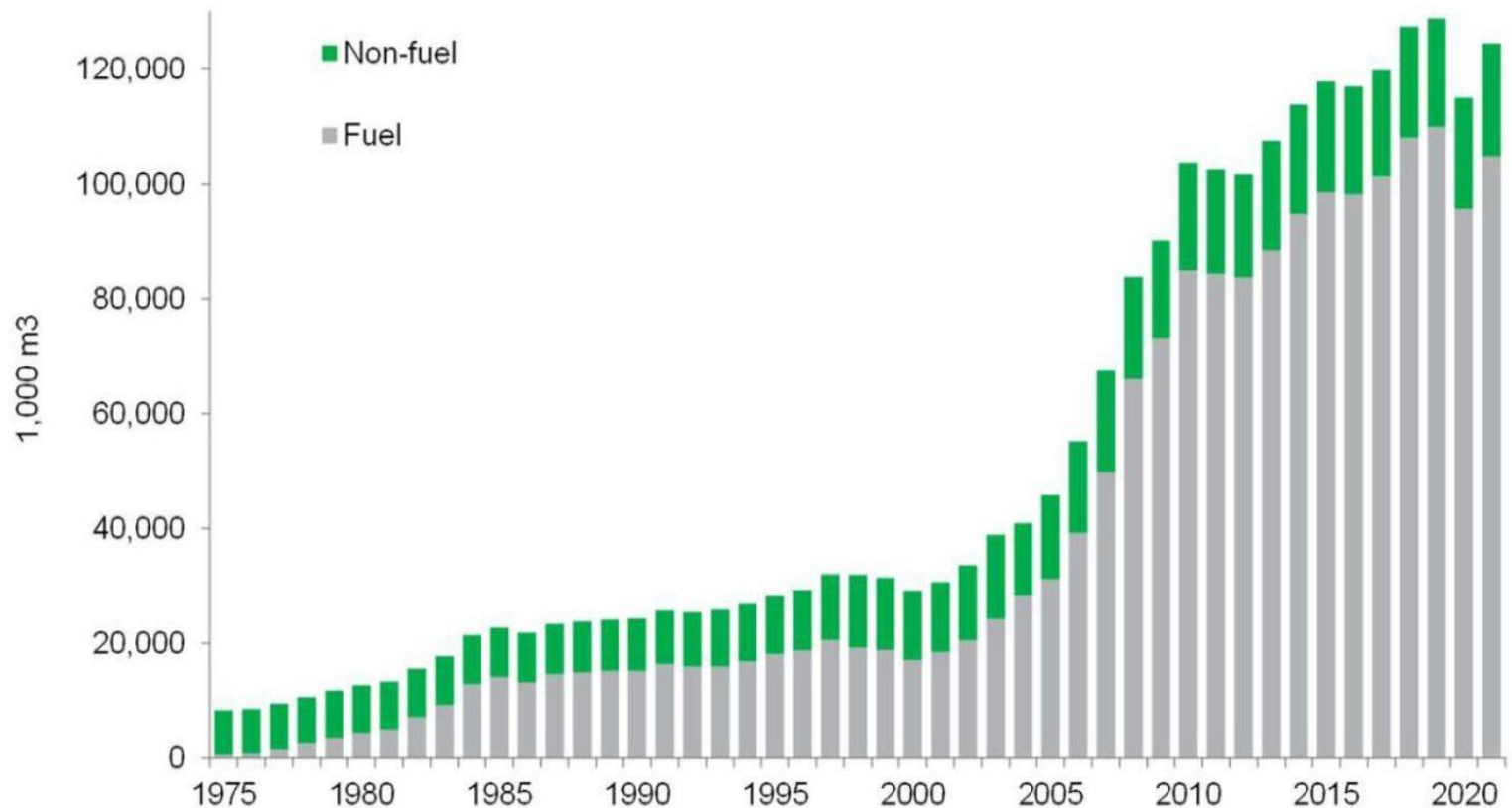


Figure 11.1: Global ethanol production by feedstock from 2007-2019.

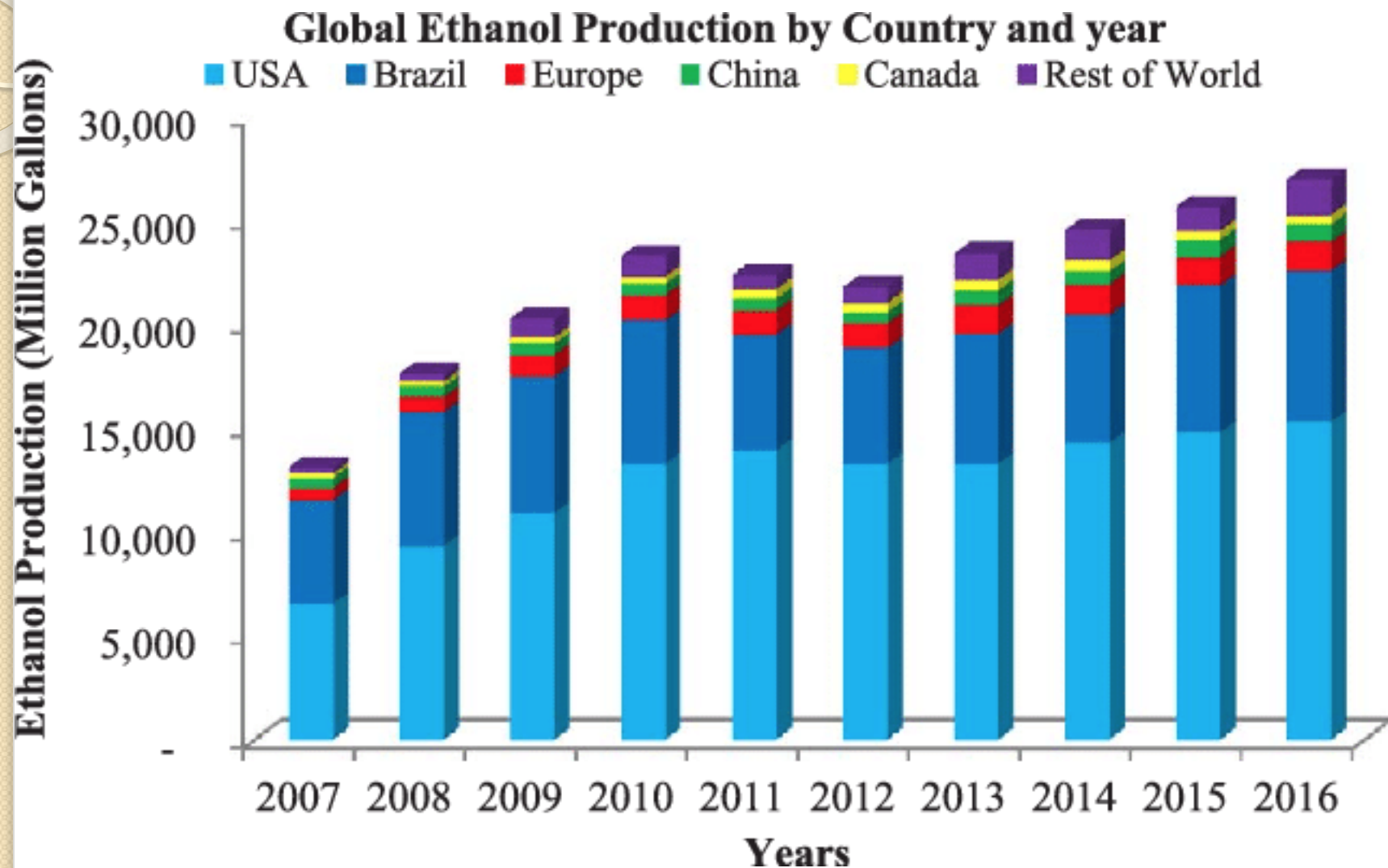
Source: [The Crop Site](#)

World Ethanol Production (1975-2020)

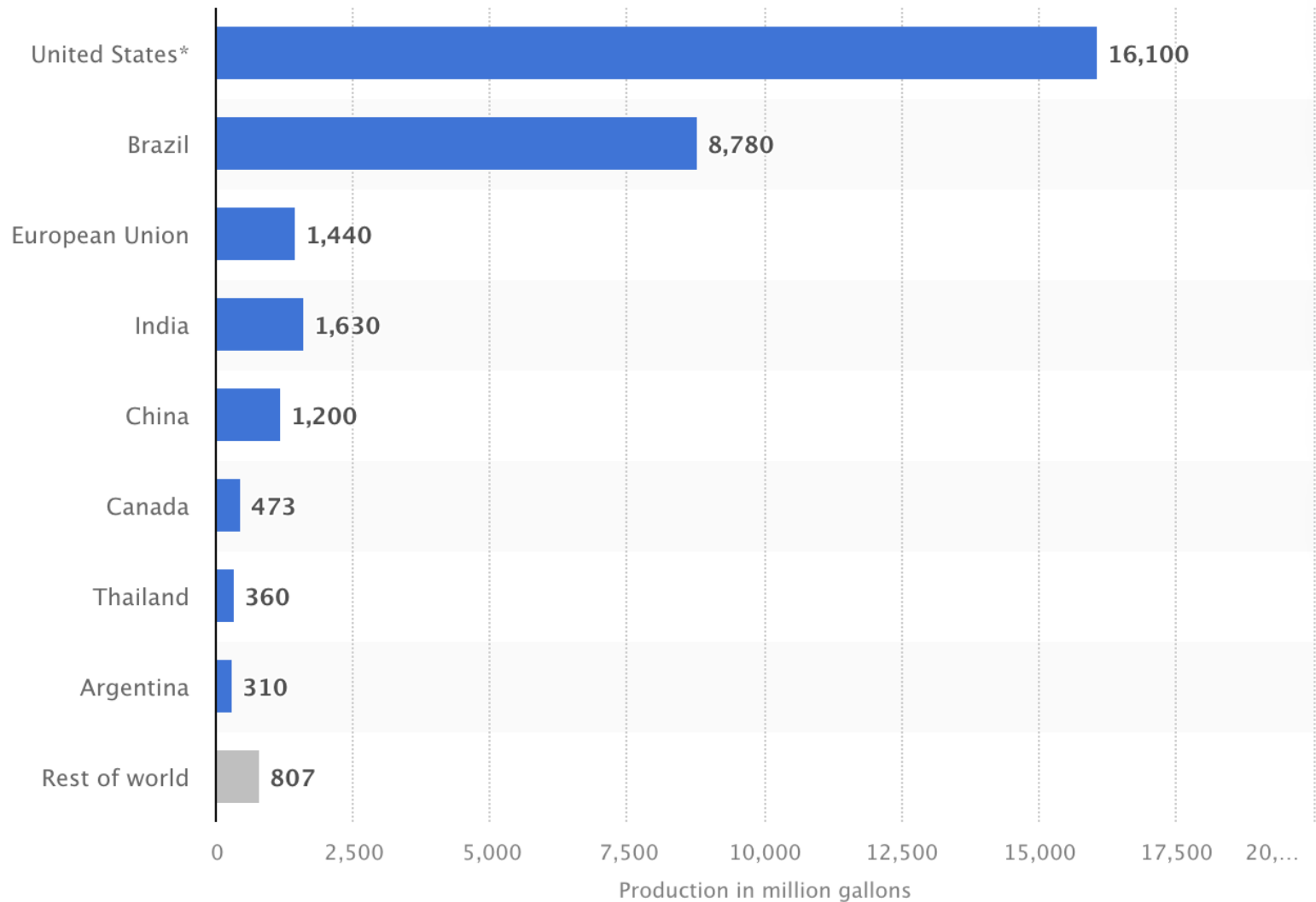
World Ethanol Production



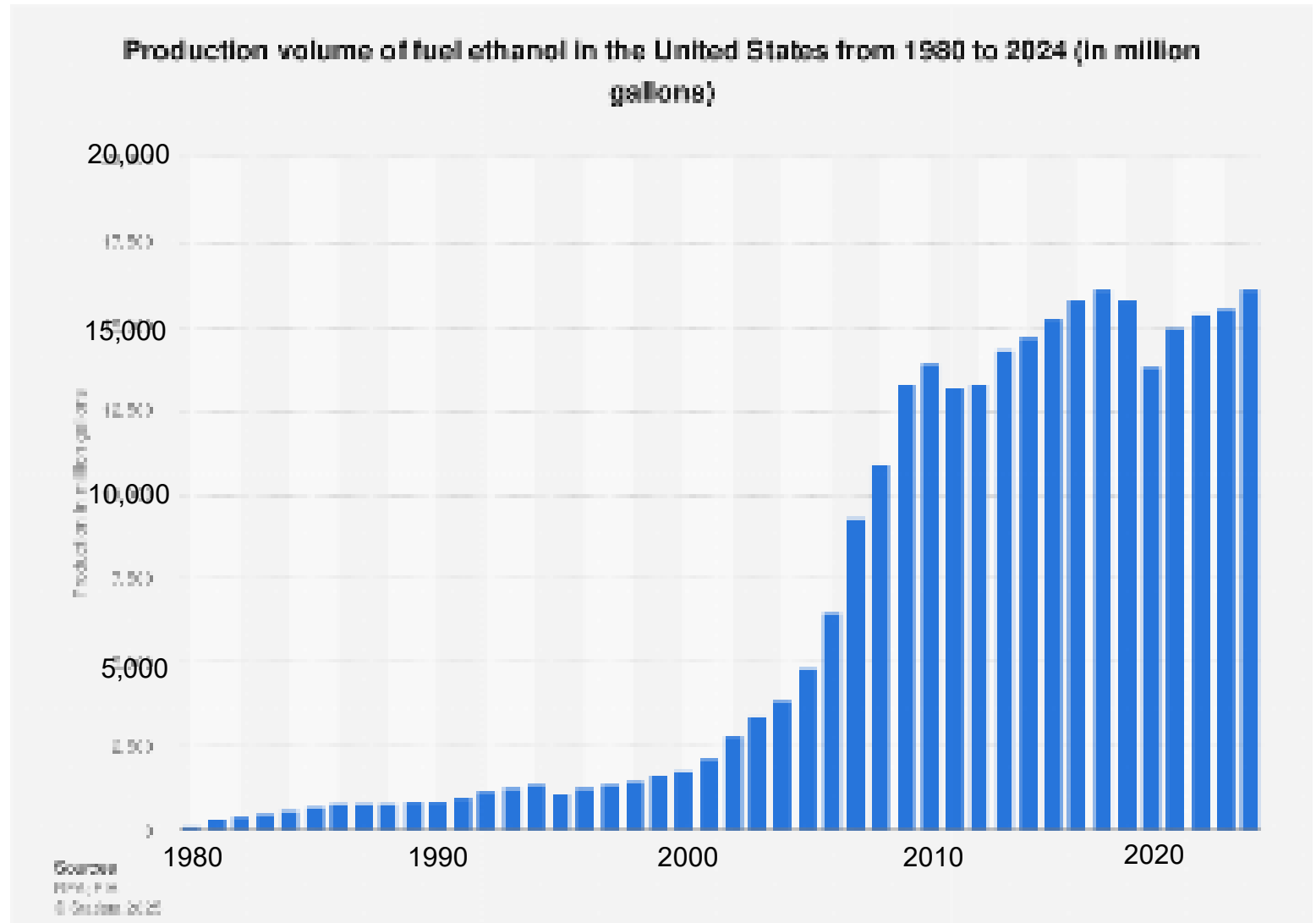
Global leaders in ethanol production



Ethanol production - 2024



US Ethanol production (1980-2024)



Where would cellulosic ethanol come from?



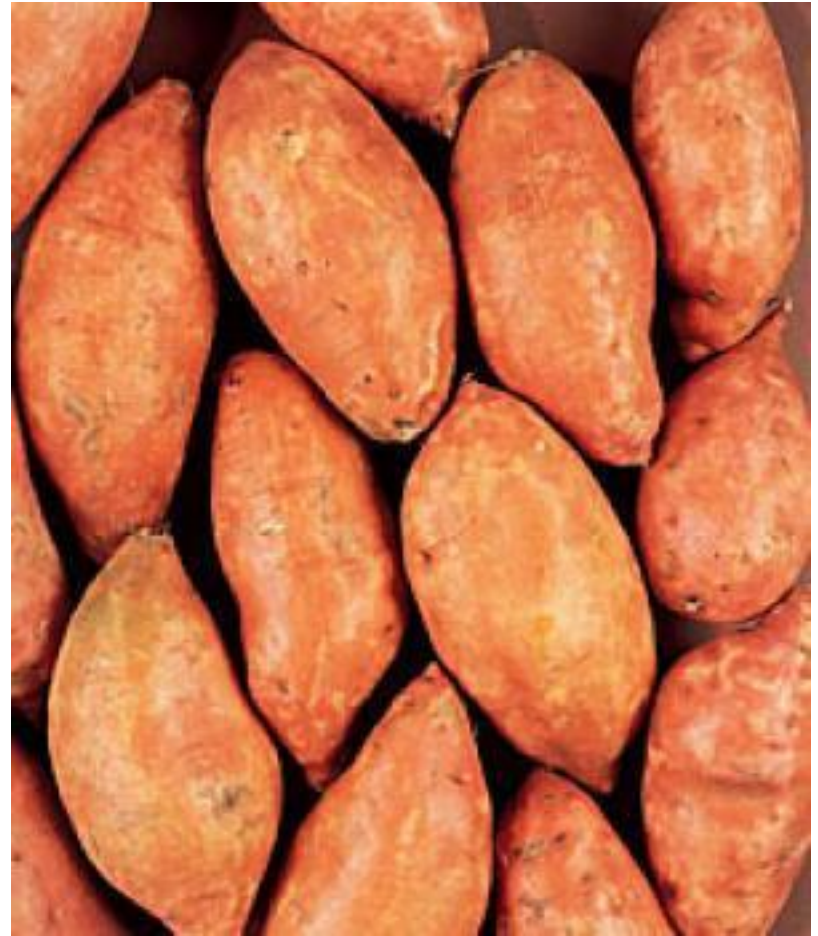
Issues relating to use of simple sugars

- Relatively little post-extraction processing needed
- Production best in tropical countries
 - Brazil nearly energy independent



Issues relating to use of starches

- Post-extraction processing simple
 - Need amylase
- Depends on materials normally used as food
 - Amenable to cultivation
 - Concern over diverting resource from food supply to energy supply
 - Concern over energy yield



Issues relating to use of cellulose

- Any plant material is potential source
- Creating source sugar more challenging
 - Macerate harvested material
 - Treat material with cellulase enzyme
 - Not really proven





Benefits of ethanol.

- Not fossil fuels
- No radioactivity
- More reliable than wind or solar

Drawbacks of ethanol.

- Low energy yield compared to inputs
- Extensive land use
- Fertilizers energy expensive, environmentally damaging