

# ETHANOL AND SUSTAINABILITY

## DOING MORE WITH LESS

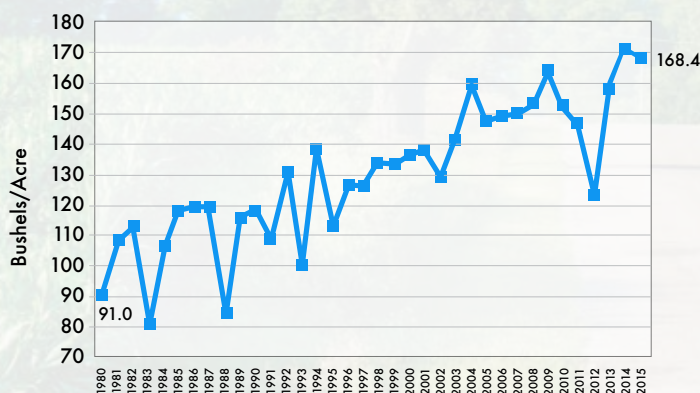
While some have argued that grain ethanol is a “mature technology” with little room for improvement, America’s ethanol producers have proven otherwise. Engineering and design enhancements, new process technologies, automation upgrades, and other advances have led to remarkable gains in efficiency.

In turn, those efficiency improvements have reduced the energy intensity and environmental impacts associated with making ethanol. In other words, today’s ethanol producers are doing more with less. Natural gas and electricity use at dry mill ethanol plants has fallen nearly 40% since 1995, while consumptive water use has been cut in half.

Meanwhile, producers are getting more out of each bushel of corn processed. Today’s dry mill plants produce 2.8-2.9 gallons of ethanol per bushel, up more than 15% over the past 20 years. In addition, each bushel processed by a dry mill is also yielding about 0.6 pounds of corn distillers oil, a feedstock for biodiesel or animal feed. Ethanol producers also captured and marketed 2.5 million tons of carbon dioxide in 2015.

But efficiency improvements aren’t just occurring at the ethanol plant—they are also happening on the farm. Thanks to new seed technologies and more efficient equipment, corn growers are seeing dramatic gains in yield per acre. At the same time, the amount of fertilizer, energy, land, and crop protection inputs required to produce a bushel of corn continues to fall precipitously.

**U.S. Average Corn Yield per Acre**



Source: U.S. Dept. of Agriculture



The result of these improvements is a smaller overall carbon footprint. According to the U.S. Department of Energy's GREET model, corn ethanol from an average dry mill reduces greenhouse gas (GHG) emissions by 34% compared to gasoline—even when hypothetical land use change emissions are included. Comparing direct emissions only, average corn ethanol reduces GHG emissions by 44% relative to gasoline.

*"The RFS2 has resulted in significant GHG reductions, with cumulative CO<sub>2</sub> savings of 354 million metric tonnes over the period of implementation."*

– Life Cycle Associates, LLC

### Corn Ethanol Efficiency Indicators

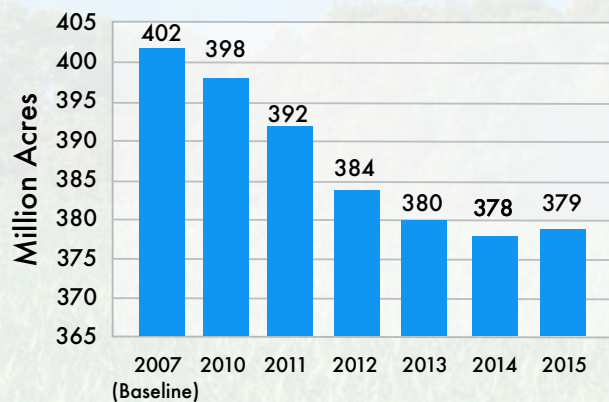
		1995	2015	% Change
Ethanol Yield – Dry Mill	gals. ethanol/bushel corn	2.55	2.83	11%
Ethanol Yield – Wet Mill	gals. ethanol/bushel corn	2.50	2.61	4%
Ethanol Yield – Industry Average	gals. ethanol/bushel corn	2.52	2.81	12%
Dry Mill Natural Gas Use	BTU/gal. ethanol	37,000	23,862	-36%
Dry Mill Electricity Use	kWh/gal. ethanol	1.20	0.75	-38%
Dry Mill Water Use	gal. water/gal. ethanol	5.5	2.7	-51%
Average Corn Yield	bushels/acre	113.5	168.4	48%
Corn Production	million bushels	7,400	13,601	84%
Nitrogen Fertilizer Application	pounds/bushel	1.15	0.83	-28%
Ethanol per Corn Acre	gals./acre	286	473	65%

Source: U.S. Dept. of Agriculture and U.S. Dept. of Energy

The use of ethanol in gasoline in 2015 reduced CO<sub>2</sub>-equivalent greenhouse gas emissions from transportation by 41.2 million metric tons — equivalent to removing 8.7 million cars from the road for an entire year.

– RFA analysis using U.S. Dept. of Energy GREET model

### U.S. EPA Estimate of Agricultural Land Use



Source: U.S. Environmental Protection Agency

U.S. EPA has determined that aggregate agricultural land use continues to fall since adoption of the RFS2 in 2007, disproving the notion that ethanol growth would cause cropland expansion.