The Lost Decade:

How Corn Ethanol Mandates Hurt Ohio's Environment and Economy

The Center For
Regulatory Solutions

SBE COUNCIL
Small Business & Entrepreneurship Council

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EXECUTIVE SUMMARY

On November 30, 2015, the United Nations (U.N.) will convene its annual Conference of the Parties meeting in Paris to discuss solutions for addressing climate change and reducing greenhouse gas (GHG) emissions. That same day, the Environmental Protection Agency (EPA) is expected to issue updated rules mandating an increase in the volume of biofuels that must be added to the nation's fuel supply, a mandate that EPA claims will reduce GHGs and contribute to a better and cleaner environment.

Building up to the U.N. meeting in Paris, President Obama and the EPA have sought to implement a sweeping regulatory agenda designed to fundamentally recast the U.S. energy sector, starting with the controversial Clean Power Plan, and more recently seeking to implement more restrictive rules for ground-level ozone, a regulation that some consider the most expensive in history. Unfortunately for small businesses struggling to meet the costs and requirements of the new GHG and ozone mandates, the ethanol mandate only complicates matters, because corn ethanol emits higher levels of GHGs and ozone precursors.

The Renewable Fuel Standard (RFS) was originally designed to lower GHG emissions by significantly expanding the volume of biofuels (corn-derived ethanol, in particular) blended into our nation's fuel supply. At the time, the prevailing narrative was that America was too dependent on foreign oil and that subsidizing the development and consumption of alternative fuels like ethanol would help the economy, contribute to greater energy security, and improve the environment. But, as often happens in Washington, the conventional wisdom was wrong. In a few short years, a domestic energy renaissance spurred in large part by technological developments in Ohio and other states transformed America into the world's leading energy producer, which has both strengthened America's geopolitical standing and, surprising to some, pushed GHG emissions to 20-year lows.

But even as these phenomena have fundamentally changed the world around us, the outdated RFS has remained intact, and in fact has been significantly expanded since it was first introduced in 2005. According to an analysis commissioned by the **Center for Regulatory Solutions** (CRS), a project of the **Small Business and Entrepreneurship Council** (SBE Council), the program's increasingly aggressive ethanol targets are hurting Ohio's economy, particularly small businesses, and the state's environment. Specifically, the ethanol mandate is driving up transportation costs in Ohio, directly impacting small business owners and their customers. Additionally, corn ethanol has increased carbon dioxide and ozone-forming emissions in the Buckeye State at a time when the Obama Administration is implementing new measures designed to significantly curtail both. For Ohio, this means that power generators, manufacturers and other employers who are, or will soon find themselves, struggling to comply with the administration's **Clean Power**

Plan and its new National Ambient Air Quality Standard for Ozone may face additional and potentially insurmountable burdens and obstacles, thanks in part to the RFS.

Impacts drive diverse opposition

SBE Council has long advocated for a reduction in year-by-year RFS targets until the policy can be phased out completely. In comments made recently to the EPA in 2014, SBE Council wrote, "Clearly, the RFS mandate makes no sense, especially given the substantial costs imposed on businesses and our economy, the environmental doubts, and the revolutionary changes in the energy position of the United States."

To get a better and more precise sense of what Ohioans know and think about the corn ethanol mandate and the RFS, SBE Council commissioned a statewide opinion survey that captured the views and attitudes of 600 registered voters throughout the state – producing a sample that was evenly split among Democrats, Republicans and Independents.

Surprisingly, and even though Ohio is considered a "corn state," more voters in the Buckeye State say they oppose the RFS and the corn ethanol mandate than support them – and that position was conveyed before a single piece of information on either the RFS or the corn ethanol mandate was provided to respondents.

Once additional information was presented, especially data on corn ethanol's environmental impacts, Ohioans who had previously supported the mandate abandoned that position entirely and en masse. In the end, nearly nine in ten respondents said they'd be less likely to support the RFS and the corn ethanol mandate under a scenario in which ethanol production and consumption contributed to deterioration of air quality and increases in greenhouse gas emissions, which is what two separate reports issued by the National Academy of Sciences found would happen.

Thankfully, high-profile political figures from both parties in Ohio have started to listen to their constituents on this issue. Even in a corn-growing state like Ohio, opposition to the RFS can be found across the political spectrum. Public officials and advocacy organizations that usually find themselves on opposite sides of issues have come to agree that the RFS is a bad deal for Ohio.

Ohio Gov. John Kasich (R) recently said the RFS "needs to be phased out" and the ethanol industry should "stand on its own." This is stunning because Kasich is running for President and delivered these comments in Iowa, a major corn-producing state. Iowa is also the first, and among the most important, of the battleground states in the Republican Presidential nomination process.

U.S. Rep. Jim Jordan (R-Ohio), chairman of the conservative House Freedom Caucus, has said ethanol producers "should be able to stand on their own in the marketplace" and "I just don't believe the government should be subsidizing any alternative fuels." On

the Democratic side, **U.S. Rep Marcia Fudge (D-Ohio)** and the Congressional Black Caucus have called for RFS targets to be eased because they have "resulted in higher prices for corn and higher prices for feed and food." And as far back as 2007, the **Central Ohio chapter of the Sierra Club** called corn ethanol a "bust" because of the amount of energy needed to produce it, the associated GHG emissions, and the land and water impacts of increased corn production.

This "odd-bedfellows" coalition of groups and individuals concerned about corn ethanol's impact on Ohio can in part be explained by several key facts contained in CRS's analysis, which include:

- The lower energy content of ethanol relative to gasoline (ethanol has roughly two-thirds of the energy content of gasoline) resulted in **$440 million in additional transportation fuel costs for Ohioans in 2014**. From 2005 to 2014, Ohioans paid more than $4 billion total in additional fuel costs due to corn ethanol. CRS's analysis shows these unnecessary energy expenditures resulted in $4.8 billion in lost GDP, $2.7 billion in lower labor income, and the equivalent of 5,500 lost jobs per year.
- Corn ethanol production and consumption have added nearly 1.92 million metric tons of CO_2-equivalent (CO_2e) emissions in Ohio from 2005 to 2014 – equivalent to the emissions of 398,000 cars **in a single year**.
- Corn ethanol production and consumption in Ohio have generated an additional 5,000 tons of volatile organic compounds (VOCs) and **28,000 tons of nitrogen oxides** (NOx) from 2005 to 2014. Both VOCs and NOx are precursor emissions that contribute to the production of ozone.
- The lifecycle water demands of producing corn ethanol in Ohio averaged more than **4.5 billion gallons per year** from 2008 to 2014, or the equivalent of the yearly water consumption of over 48,000 households.
- The number of acres of land previously protected under Ohio's Conservation Reserve Program (CRP) have decreased **by more than 20 percent** from 2008 to 2014, while the total number of corn acres planted have increased.
- More than 8,500 tons of cumulative soil erosion have been recorded in Ohio between 2005 and 2014 as a result of mandates that encouraged additional volumes of corn to be grown.

Inspector-General launches investigation

With the EPA set later this month to announce updated requirements for the ethanol volumes that must be blended into the nation's fuel supply, the agency's Inspector General **announced** on Oct. 15 that it would conduct an investigation into EPA's calculation of the lifecycle environmental impacts of the RFS. The investigation follows years of media scrutiny of the RFS, which raised serious concerns about the impact of corn ethanol mandates. In 2013, the ***Associated Press*** reported that the rush to plant corn "wiped out millions of acres of conservation land, destroyed habitat and polluted water supplies." In 2008, ***Time***concluded that ethanol "increases global warming, destroys forests and inflates food prices."

National lawmakers and advocacy groups that are usually at odds have found a common cause in criticizing the RFS. In February 2015, **U.S. Sens. Diane Feinstein (D-Calif.) and Pat Toomey (R-Pa.)** introduced a bill to repeal the corn ethanol mandate in the RFS. Feinstein called the mandate "unwise and unworkable," while Toomey said the RFS "drives up gas prices, increases food costs, damages car engines, and is harmful to the environment."

The bipartisan Feinstein-Toomey bill reflects growing opposition to the RFS from both environmental groups and pro-business organizations. For example, in May 2015, the **Environmental Working Group** (EWG) argued "the federal corn ethanol mandate has resulted in a massive influx of dirty corn ethanol, which is bad for the climate and bad for consumers." In 2010, the **Natural Resources Defense Council** (NRDC) warned about the reliance on corn-based ethanol – rather than cellulosic ethanol produced from feedstocks such as grass, wood, and crop residues – to meet the RFS mandates. "It's time to transition from corn ethanol's pollution and pork to a new generation of more sustainable biofuels that brings us closer to real energy independence," the NRDC urged.

"[W]e don't need an additional 1.4 billion gallons of corn ethanol, or the higher prices for grains and more deforestation that come with it. … It's time to transition from corn ethanol's pollution and pork to a new generation of more sustainable biofuels that brings us closer to real energy independence."

Natural Resource Defense Council

"Study shows tax payers subsidizing ethanol at $4.18 per gallon." NRDC, March 10, 2010.

Al Gore, pro-business advocates unite against corn ethanol

The same year, NRDC issued its warning, **former Vice President Al Gore** – a leading environmental activist – said that his past support for corn ethanol was a "mistake" and candidly admitted that his position was influenced by his attempts to win votes in Iowa while running for President in 2000. Gore and the environmental movement in general are continually battling pro-business groups on a range of policy issues. But in criticizing the RFS, they have found a rare point of agreement with supporters of pro-growth business priorities.

"It is not a good policy to have these massive subsidies for (U.S.) first generation ethanol. … First generation ethanol I think was a mistake. The energy conversion ratios are at best very small. It's hard once such a program is put in place to deal with the lobbies that keep it going. … The size, the percentage of corn particularly, which is now being (used for) first generation ethanol definitely has an impact on food prices. The competition with food prices is real."

Vice President Al Gore

"U.S. corn ethanol 'was not a good policy'-Gore." Reuters, November 22, 2011.

Conclusion

Until recently, the debate over the RFS has been driven by politics, not facts. But that is beginning to change. It is clearer now than ever before that the RFS benefits very few at the expense of very many. The corn ethanol lobby remains a powerful force in Washington, to be sure, but even corn-producing states like Ohio are beginning to recognize that the costs of the RFS far outweigh the benefits.

Today, the corn ethanol lobby's grip on the federal government is loosening. Our leaders have an opportunity to reform U.S. biofuels policy so it aligns with the nation's new energy reality – and not the projections and promises from ten years ago, when the RFS was initially implemented, that have been proven false. For the sake of Ohio's small businesses and environment, it is an opportunity that must be seized.

Left, Right and Center Agree: The RFS is Not Working

Whether we know it or not, we all use ethanol each and every day. We have little choice. Under the RFS, the federal government has mandated that our fuel supply contain at least 10 percent ethanol, and some interest groups in Washington, D.C. are demanding that those levels be pushed higher still. The EPA is set to decide on a new RFS mandate by **November 30, 2015**. But at the same time, the federal government's ethanol policies have come under fire from a diverse array of groups from across the political spectrum. Environmental groups like the Sierra Club, the EWG and the NRDC argue that corn ethanol is actually worsening our environment. The American Highway Users Alliance (AHUA) and the Marine Retailers Association of the Americas (MRAA), whose members have been harmed by the corrosive nature of ethanol-based fuels, are also among the most vocal critics of the RFS.

"Using the EPA's own estimate, we calculate that the corn ethanol mandate has been worse for the climate than projected emissions from the controversial Keystone XL pipeline. … So far the federal corn ethanol mandate has resulted in a massive influx of dirty corn ethanol, which is bad for the climate and bad for consumers. The only interest it benefits is the ethanol industry. As we've said before, it's time for Congress to correct course and reform the broken RFS to make way for truly green biofuels."

Environmental Working Group
"How Corn Ethanol Is Worse For Climate Change Than The Keystone Pipeline." EWG, May 29, 2015.

"The RFS policy was originally intended to counter rising oil imports and heightened demand for gasoline in the mid-2000s. But an unanticipated boom in domestic energy production, improvements in vehicle fuel economy technologies, unanticipated market failure of some ethanol products, and the weak economy disproved the assumptions that drove energy policies at the time… To make matters worse, higher ethanol fuel blends have less energy content than regular gasoline, delivering lower fuel economy. Ethanol contains 33 percent less energy per gallon than gasoline and that forces Americans to return to the pump more often and spend more money."

Gregory M. Cohen
President and CEO of the American Highway Users Alliance
"Highway Users Alliance on federal policy affecting I-90 commuters," Cleveland.com, July 10, 2014.

"MRAA is opposed to increased ethanol levels in transportation gasoline and is part of a multi-industry coalition, Smarter Fuel Futures, which advocates for a complete reform of our country's biofuel policies."

William Higgins
Marine Retailers Asociation of the Americas
"EPA Releases Ethanol Standards." MRAA.com. June 9, 2015.

In addition to advocacy groups, newspaper editorial boards from across the country have warned of the unintended consequences of the ethanol mandate. For example, in 2007, the ***Los Angeles Times*** wrote:

> *Corn is a very water- and chemical-intensive crop. Ordinarily, farmers rotate crops annually to avoid soil exhaustion, but high corn prices encourage them to plant corn in the same fields year after year. The only way to make this work is to pour on more fertilizers, which seep into waterways and create algae blooms that suck up all the oxygen and kill everything else.*

In 2014, the ***Chicago Tribune*** argued the ethanol mandate should be cut significantly, with the ultimate goal for it to be eliminated entirely. The views of these editorial boards have been echoed by the ***Wall Street Journal***, ***The Pittsburgh Tribune-Review***, ***Fort Wayne News-Sentinel*** and many others.

On a local level, the ***Toledo Blade*** recently cited fertilizer runoff from increased corn farming activities as the principal cause of Lake Erie's toxic algae bloom:

> *The best preventive measure would be a formal declaration by the U.S. Environmental Protection Agency that the western Lake Erie watershed is "impaired." Under the federal Clean Water Act, that definition would permit tougher regulation of the sources of pollution — especially runoff of excess manure and fertilizer from farm operations — that promote the growth of harmful algae blooms in the lake.*

Despite a growing consensus that the corn ethanol mandate was a mistake and should be repealed, the powerful **corn ethanol lobby** has considerable leverage over presidential candidates who want to show well in the Iowa Caucus. There is a **campaign effort** in place specifically dedicated to promoting the RFS in Iowa, and according to its chairman, Bill Couser, "failing to support the renewable fuel standard means failing to support America's economy and national security."

> *"Subsidizing ethanol benefits two well-organized groups: corn growers and ethanol producers (especially the corporate giant Archer Daniels Midland). As a result, it's bad policy with bipartisan support."*
>
> **Paul Krugman**
>
> ***Krugman, Paul. "The Sum of All Ears." New York Times, January 29, 2007.***

This corn ethanol lobby's influence has swayed several current presidential candidates. For example, **Hillary Clinton** voted against ethanol 17 times while a member of the U.S. Senate and called the RFS "an astonishing anti-consumer government mandate" In 2002. But in **May 2015**, the Democratic presidential front-runner flipped on the issue in dramatic fashion. "The United States should also continue supporting — and improving — the RFS and other federal incentives that have been a success for Iowa and much of rural America," Clinton wrote in an Iowa newspaper op-ed.

Clinton's main rival in the Democratic primary, U.S. Sen. Bernie Sanders **of Vermont**, is feeling the pressure, too. In 2011, Sanders proudly boasted he voted "to end the ethanol subsidy which would save taxpayers $3 billion for the remainder of this year." But when asked for his views on the RFS during an **Iowa TV interview** earlier this year, Sanders

sang a very different tune. “Iowa is one of the leaders in the country in wind and biofuels,” he said. “So, I support the Renewable Fuel Standard.”

Some Republicans running for President have also come out in support of the RFS when speaking to audiences in Iowa. When asked whether he would support the RFS, Donald Trump told an Iowa crowd earlier this year that “ethanol is terrific…and I am totally in favor of ethanol, 100 percent.” New Jersey Gov. **Chris Christie** did not equivocate when asked if he supported the RFS, saying he would "absolutely" support the mandate if elected President. Former Florida Gov. **Jeb Bush** is on record claiming that the RFS “has worked, for sure... It has been a benefit to us as we've reduced our dependency on foreign sources of oil.”

Despite this political pressure, Ohio’s Governor, **John Kasich**, has been fairly consistent in his oposition to subsidies for ethanol, telling a crowd in Iowa, “I’m not against ethanol, but I’m not for any subsidies.”

> *“They tell me that’s going to kill me in Iowa, but I’m not changing my position to get votes.”*
>
> **John Kasich**
>
> ***“Strong Positions in Iowa.” Associated Press, April 26, 1999.***

What these presidential hopefuls are not saying – perhaps because they don’t know – is that the corn ethanol mandate has imposed substantial environmental and economic costs throughout the country, particularly in the handful of states that produce the vast majority of ethanol blended into our fuel stock.

This report details how the corn ethanol mandate has impacted Ohio, which, as the **eighth** leading corn producer in the United States, has dedicated 3.7 million acres of farmland to corn. Ohio has ramped up its corn production in response to the RFS. For example, in 2007, Ohio farms **produced 150 bushels of corn per acre**. That has grown to 176 bushels per acre in 2014. Nearly all Ohio corn is field corn, suitable for livestock feed and industry. Thirty percent of that corn goes to ethanol distillers, which sell the liquid product to blenders, which in turn mix it with gasoline before distribution to service stations.

How We Got Here, and What Comes Next

In July 2005, Congress passed and President George Bush signed the bipartisan *Energy Policy Act*, which established the Renewable Fuels Standard (RFS). The RFS created a set of mandates – known as **Renewable Volume Obligations (RVOs)** – that require ever-increasing volumes of ethanol to be added to the nation's fuel supply. Politicians supporting the ethanol mandate **promised** a cleaner environment, enhanced energy security, and greater economic support for domestic farmers and rural communities across the country

In 2007, after Democrats won control over both houses, President Bush found common ground with the new congressional majority and greatly expanded the RFS mandates via passage of the Energy Independence and Security Act (EISA). Celebrating the agreement, then-Speaker of the House **Nancy Pelosi (D-Calif.)** said: "We will send our energy dollars to the Midwest, not the Middle East."

In EISA, Congress **mandated** that 100 million gallons of cellulosic ethanol – produced from non-starchy feedstock, such as grass, wood, and crop residues – had to be blended into the fuel supply in 2010, 250 million gallons had to be added in 2011, and then, from there, 16 billion gallons were to be introduced by 2022. The amount of ethanol derived from corn was capped at 15 billion gallons, starting in year 2015.

However, the targets set by Congress, which included a mandate for consumption of cellulosic ethanol, have proved elusive because converting cellulosic feedstock into usable energy is much more challenging than starch-based crops, like corn.

In fact, commercial volumes of cellulosic ethanol were essentially non-existent in 2010 and 2011, and only 20,000 gallons **were produced in 2012** by a company that subsequently filed for bankruptcy. In 2013, about 230,000 gallons of cellulosic biofuel were **produced by KiOR**, which went bankrupt in 2014. In effect, Congress mandated the use of a fuel that did not – and still does not – exist on a commercial scale. In the last few years, production of cellulosic ethanol has increased modestly, but nowhere near the amount mandated by EISA.

Despite this setback, EPA Administrator Gina McCarthy – whose agency is responsible for implementing the RFS – is pledging to get the RFS mandate "**back on track**" and eventually align its targets with congressional mandates. Pursuant to this strategy, EPA is proposing to set 2014 cellulosic levels to correspond with what was actually produced and used as fuel, or 33 million gallons. For 2015, EPA is proposing 106 million gallons, and will up the amount to 206 million gallons in 2016. This would allow set **volumes** of corn ethanol to satisfy the total RFS mandate at 13.25 billion gallons, 13.4 billion gallons, and 14 billion gallons for 2014, 2015, and 2016, respectively. EPA is under court order to issue a final decision by November 30, 2015.

Broken Promises

Following the passage of the RFS in 2005, politicians rushed to associate themselves with the popular and bipartisan new mandate. Then U.S. Senator Barack Obama of Illinois – the nation's second largest corn-producing state – **hailed** "homegrown, alternative fuels like ethanol." He also **lectured** President Bush for seeking a partnership with Brazil, a leading producer of ethanol, because in the Senator Obama's view "the U.S. needs to dramatically expand domestic biofuels production, not embrace a short term fix that discourages investment in the expansion of the domestic renewable fuels in industry." For his part, President Bush called on Congress in his 2007 **State of the Union speech** to require production of 35 billion gallons of renewable and alternative fuels in 2017.

Former President Bush and President Obama were far from alone in supporting ethanol. U.S. Senator Dick Durbin, also from Illinois and a leading Democrat in the Senate, **boasted**: "[Ethanol] is near and dear to my heart. And it is homegrown. We do not need to have a Saudi prince smiling at us to find a gallon of ethanol." Similarly, U.S. Senator **John McCain (R-Ariz.)** declared, "I support ethanol and I think it is a vital, a vital alternative energy source not only because of our dependency on foreign oil but its greenhouse gas reduction effects."

In Ohio, politicians on the left and right embraced the promise of corn ethanol. Former Republican U.S. Senator George Voinovich, who served on the Senate committee that wrote the mandate, **promised** cleaner vehicle emissions as a result of ethanol use: "Expanding the use of ethanol will also protect our environment by reducing auto emissions, which will mean cleaner air and improved public health."

U.S. Rep. **Marcy Kaptur**, a Democrat representing the Toledo area, called ethanol "a homegrown fuel source that reduces our dependence on foreign oil and pumps half a billion dollars a year into the Ohio economy." **U.S. Senator Sherrod Brown (D-Ohio)** has said that the RFS was helping achieve other goals for reducing reliance on oil, including the increased use of biofuels made from other natural materials such as switchgrass, wood waste and corn stalks.

Corn Ethanol's Costs for Ohio Small Businesses and the Local Economy

With the real-world environmental impacts of corn ethanol production and use becoming more apparent by the day, advocates of the RFS and higher ethanol volume requirements often prefer to discuss what they believe to be the significant economic benefits associated with expanding the mandate. These benefits, they say, include

increased farming income, additional ethanol-related jobs, and greater support for local, often rural communities. But these advocates often ignore the serious economic costs to average consumers who don't happen to be in the business of growing and selling corn – in particular, higher fuel costs.

While ethanol and gasoline are priced similarly, ethanol provides consumers with only two-thirds of the energy content per gallon compared to gasoline. In other words, Ohioans are paying the same price for ethanol as gasoline but are getting one-third less mileage for each gallon of ethanol consumed. This translates into an economic loss for motorists to the tune of $440 million in additional transportation fuel costs for Ohioans in 2014 (Figure 1).

"Congress created the renewable fuel standard in 2005 with several goals in mind: energy security, rural economic development and environmental protection. But a more fundamental problem is its high cost when compared with conventional gasoline. And that higher cost is directly related to its lower energy density."

Robert Bryce
"End the Ethanol Rip-Off." New York Times, March 10, 2015.

Figure 1: Annual and Cumulative Ohio Household Income Loss, 2005–2014

(Calculated using Ohio ethanol consumption from EIA SEDS data and monthly gasoline and ethanol rack prices from USDA Economic Research Service)

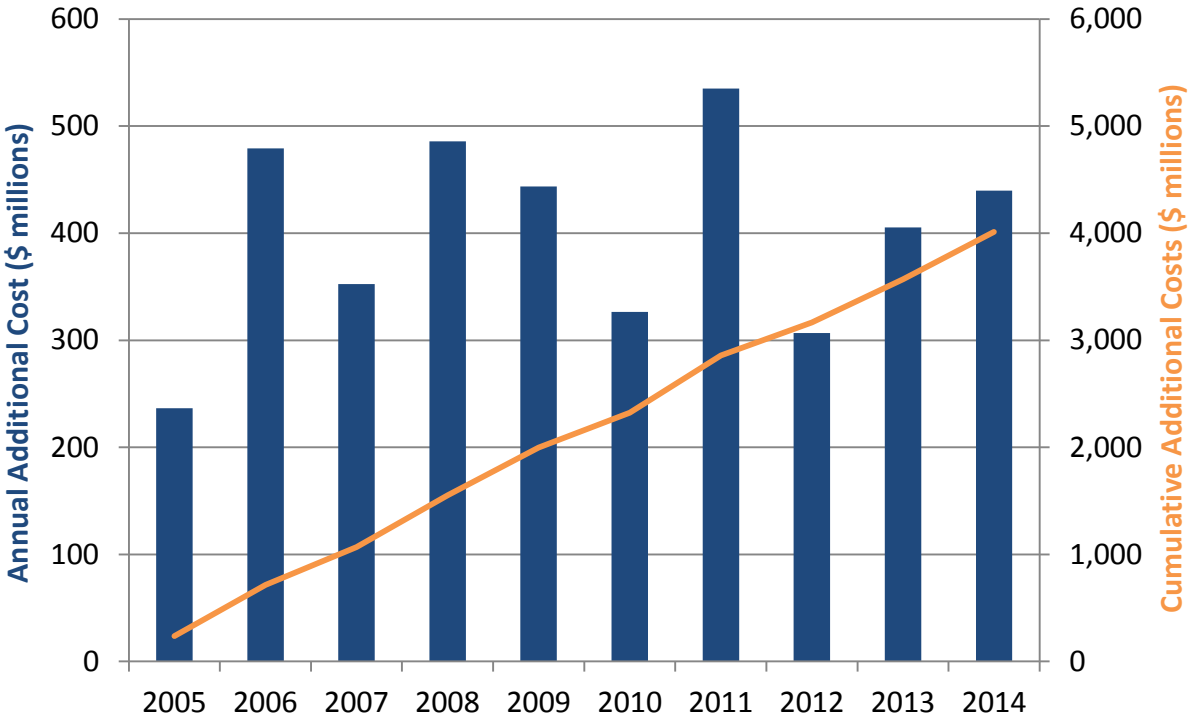


Figure 1 shows that Ohioans have paid more than $4 billion cumulatively in additional fuel costs due to the presence of ethanol in their fuel tanks since the RFS was first implemented in 2005. The resulting aggregate economic losses include a $4.8 billion hit to Ohio's GDP over that span, $2.7 billion in lower labor income, and 55,000 job-years (or 5,500 jobs per year during the 10 year period) lost, as shown in Table 1.

Table 1: Aggregate Economic Impacts due to Reduced Household Spending in Ohio, 2005-2014

Economic Impact	Aggregate Economic Loss
GDP	$4.8 billion
Labor Income	$2.7 billion
Employment	55,000 jobs-years

The reduction in labor income is especially concerning considering household income in Ohio has fallen in real terms since the 1980s. According to the **Census Bureau**, household median income in Ohio was $46,398 in 2013 while median income in 1984 was $51,845 in 2013 dollars.

Scientists, Experts Separate Fact from Fiction

In addition to the significant economic toll that corn ethanol has imposed on Ohio, policy-makers are slowly, sometimes reluctantly, coming to grips with the serious environmental costs of the corn ethanol mandate. These costs include increased GHG emissions, increased pollution of water and waterways and increased emissions of ozone precursors.

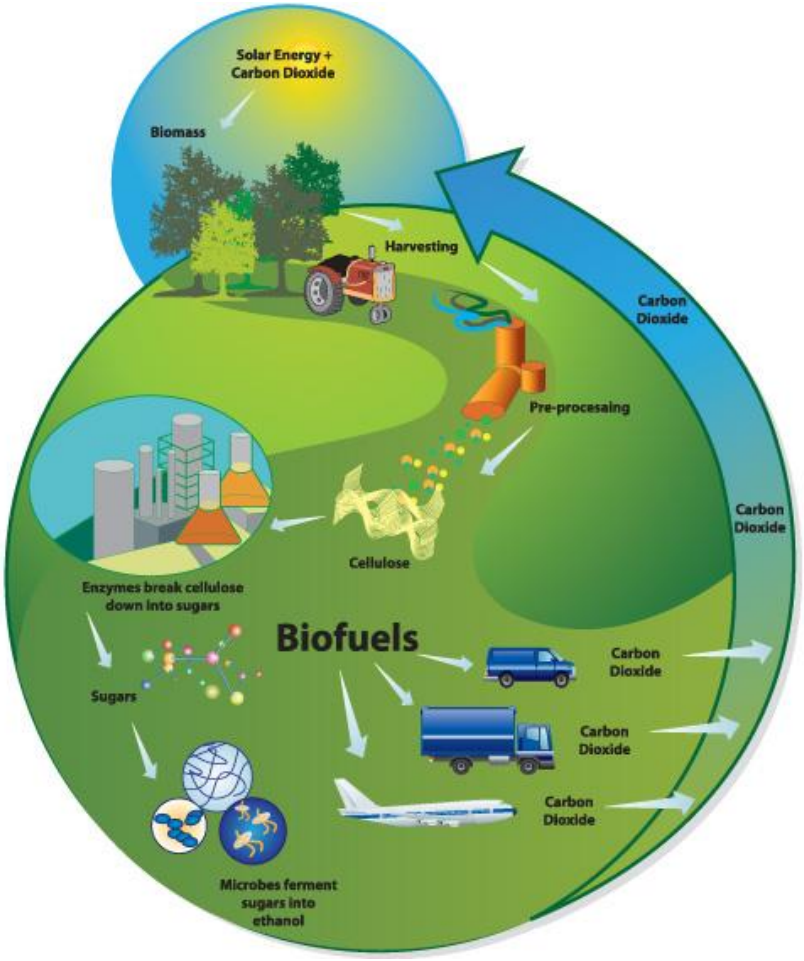
Unlike politicians, the scientific community began sounding the alarm about the RFS almost immediately after the mandate became law. In January 2008, a **study** in the journal *Science* warned that the RFS might undermine GHG reductions if the policy encouraged farmers to plow into untouched grassland or farmland that had been set aside for conservation. Developing this conservation land releases stored carbon dioxide and, therefore, increases GHG emissions. These concerns were **echoed** by Dr. Dan Kammen and Dr. Michael O'Hare of the Energy and Resources Group at the University of California, Berkeley:

> *Simply said, ethanol production today using U.S. corn contributes to the conversion of grasslands and rainforest to agriculture, causing very large GHG emissions. Even if only a small fraction of the emissions calculated in this crude way [through land use change] are added to estimates of direct emissions for corn ethanol, total emissions for corn ethanol are higher than for fossil fuels.*

Similarly, a **study** out of the University of Minnesota found that corn ethanol has a greater impact on climate change than gasoline. In 2011, the National Academy of Sciences (NAS) **reported** that the RFS may be an ineffective policy for reducing global GHG emissions because of how biofuels are produced and what land-use or land-cover changes occur in the process. A 2013 **study**, published in the *Proceedings of the National Academy of Sciences*, used satellite data to confirm that the RFS

> *"As farmers rushed to find new places to plant corn, they touched off a cascade of unintended consequences, including the elimination of many acres of conservation land."*
>
> **Associated Press**
> ***"AP investigation explores hidden cost of ethanol." Associated Press, November 6, 2013.***

encouraged the development of conservation land. The **graphic** below shows the GHG lifecycle of ethanol.



In addition to increasing GHG emissions, the ethanol lifecycle emits higher concentrations of ozone precursors than gasoline. Nitrogen oxides and VOCs react in the atmosphere in the presence of sunlight to form ground-level ozone. According to a 2010 **study** by Stanford Univeristy researchers, vehicles running on E85, a blend of gasoline and ethanol that is 85 percent ethanol, produce different byproducts than gasoline and generate substantially more aldehydes, which are precursors to ozone. The **NAS** study also reported that overall production and use of ethanol will result in higher pollutant concentrations for ozone and particulate matter than their gasoline counterparts on a national scale.

The National Oceanic and Atmospheric Administration (**NOAA**) earlier this year confirmed the role that ethanol plays in contributing to higher ozone levels. According to NOAA, "We found a pretty substantial increase in ozone production from E85 at cold temperatures, relative to gasoline, when emissions and atmospheric chemistry alone were considered." Moreover, NOAA found that airborne emission levels captured downwind from an ethanol fuel refinery in Decatur, Illinois, were 30 times higher than previous government estimates. Volatile organic compounds (VOCs) were five times higher than inventories estimated, and emissions of ethanol itself, which is also a VOC, were about 30 times higher.

Ethanol production also exacts a heavy toll on water resources, from growing crops to processing those materials into the fuel. The 2011 **NAS study** found that the increase in corn production had adverse environmental impacts on surface water and groundwater, including hypoxia, harmful algal blooms, and eutrophication. The NAS paper predicted that additional increases in corn production – mandated under the law thanks to the RFS – would have additional negative environmental consequences.

In light of all these environmental impacts, the EPA Inspector General (IG) recently launched an investigation into EPA's methodology for calculating the GHG benefits associated with the RFS. In a **letter** posted on its website, the EPA IG wrote that it "plans to begin preliminary research" to determine whether EPA has properly accounted for the full GHG emissions of biofuels. The IG indicated that it would be looking more closely at published studies, including the 2011 NAS study, to determine if EPA's RFS analysis is properly supported.

Corn Ethanol's Environmental Toll on Ohio

Given the serious environmental consequences associated with the RFS, a diverse, bipartisan set of leaders and organizations in Ohio is starting to speak up.

For example, not all farmers and agricultural interests support ever-increasing ethanol mandates. The Ohio Poultry Association is **on record** supporting RFS reform:

> *We strongly believe that it is time for Congress to reexamine the corn-based ethanol mandate and allow the market—not the government—to determine the best use of our valuable food supply. Although it has come at a significant cost, the mandate has resulted in a larger corn ethanol industry that has already benefitted from over three decades of federal support.*

Moreover, David Uible, a Clermont County commissioner and farmer, recently **weighed in** on the ethanol debate:

> *How we utilize our natural resources and farm our land is a critically important decision for us that will impact future generations. Interestingly, a federal mandate with good intentions - to reduce our fossil fuel consumption - is having unintended consequences that greatly impacts how we're farming our land.*
>
> *There's no question, it's time to reform the RFS…It's time for us to raise our voices. If we want to see real change in Ohio, we need to work together to fight for what is best for our state.*

Adding to the growing list of concerned parties over corn ethanol are Ohio environmental groups. The Ohio Environmental Council (OEC) has long opposed special treatment for ethanol. In 2007, the group **objected** to a state plan to raise air-pollution limits for ethanol plants without requiring more state oversight or inspections. "Putting an exception to the rule for one portion of Ohio industry is one bad policy," said Trent Dougherty, an attorney with the OEC.

Elected officials from both sides of the aisle have also criticized the corn ethanol mandate. On the Republican side, Ohio Congressmen Jim Jordan, Brad Wenstrup, and Steve Chabot recently **co-sponsored** the Renewable Fuel Standard Elimination Act, federal legislation that would repeal EPA's RFS program.

In an interview with CRS, Washington County Commissioner Ron Feathers described the RFS as an "absolute disaster, especially from an environmental perspective."

> *"It's not fair to ask rural people to accept dirtier air so that people in cities can have potentially cleaner air."*
>
> **Jack Shaner**
> ***Lobbyist with the Ohio Environmental Council***
> ***Hunt, Spencer. "Ethanol: Is corn-based fuel worth tax deals, pollution?" Columbus Dispatch, August 6, 2007.***

Rep. Marcia Fudge, aDemocrat Congresswoman from Cleveland, has also been critical of the RFS and its role in pushing food costs higher.

Research commissioned by CRS suggests that Ohioans who oppose expanding the RFS and the corn ethanol mandate have science on their side. CRS's analysis reveals that the RFS has already exacted a heavy toll on the Ohio environment, an impact that will only get worse if EPA follows through with increasing existing levels to higher, and potentially even unattainable, congressionally prescribed levels. Moreover, the RFS has imposed severe economic costs on Ohio consumers, businesses and motorists, due in large part to higher fuel costs associated with the lower energy content contained in ethanol.

> *" I just don't believe the government should be subsidizing any alternative fuels. I think they should be able to stand on their own in the marketplace."*
>
> **Stephen Koff**
> ***"Ethanol debate puts conservative, corn-state congressmen in quandry." Cleveland.com, January 17, 2014.***

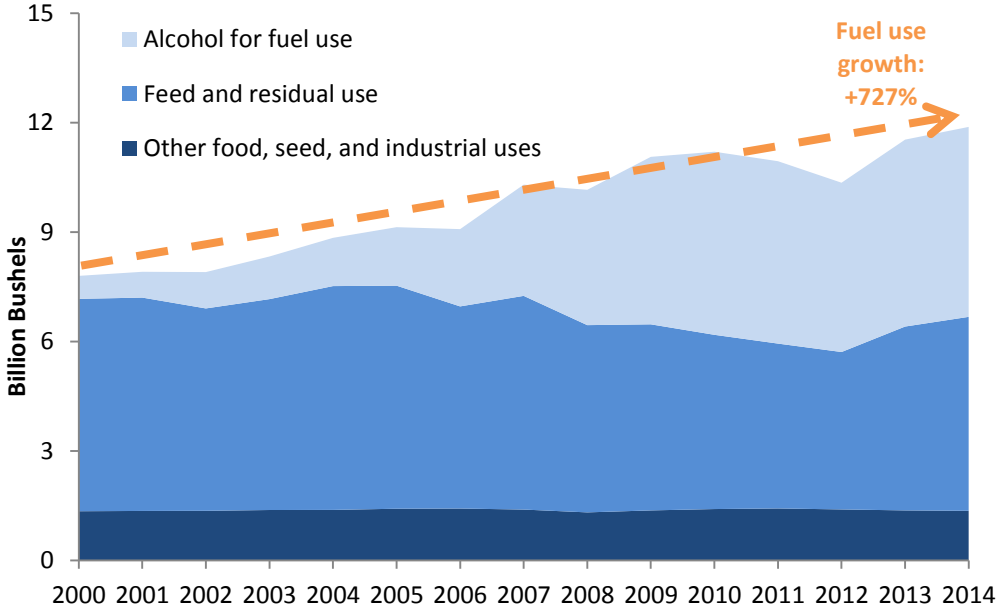
Historical GHG and Criteria Pollutant Impacts of the RFS

GHG Analysis

When corn ethanol's emissions profile is accurately and properly calculated, it becomes clear that corn ethanol is actually worsening – not improving – our environment. A recent University of Tennessee **study** found that ethanol's lifecycle GHG emissions actually exceed those of gasoline when land use changes associated with its production are properly measured. In addition, the study found that lifecycle emissions of other pollutants – volatile organic compounds (VOCs), nitrogen oxides (NOx), particulate matter (PM), sulfur dioxide (SOx), and ammonia (NH_3) – greatly exceed those of gasoline.

In order to better understand corn ethanol's effect on the environment, it's important to consider how the ethanol industry has changed over time. Using USDA **data** on domestic corn usage, Figure 2 below shows that corn ethanol production grew from 630 million to 5.2 billion bushels, an increase of 727 percent in the United States over just the past 15 years.

Figure 2: Corn Usage Across the United States, 2000-2014



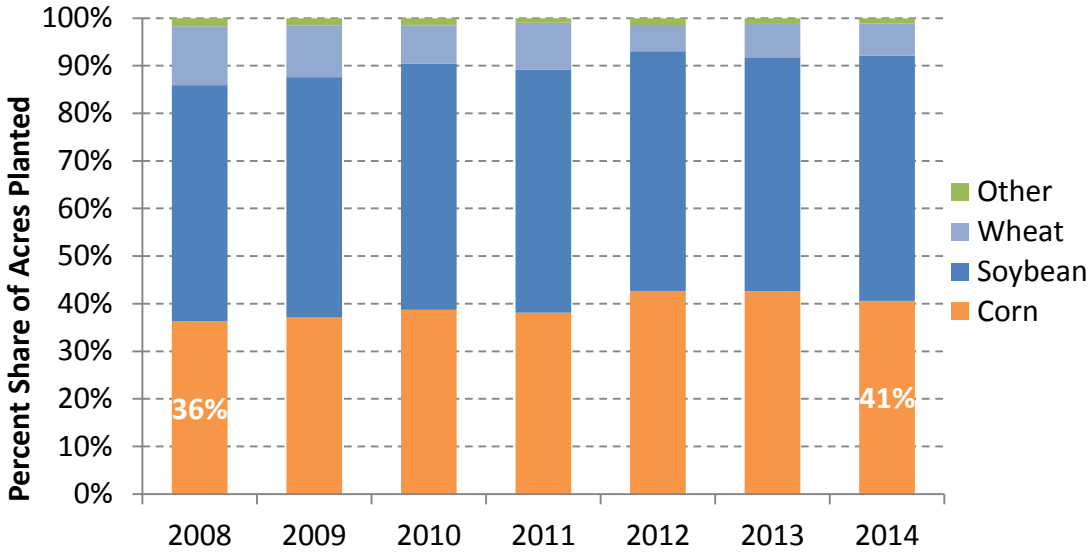
As government-mandated corn ethanol production and consumption have risen, farmers looking to benefit from inflated prices replaced other field crops by planting more corn (see Figure 3 below for the yearly change in corn acres planted in Ohio). In 2008, corn accounted for 36 percent of the total field crop acres planted in Ohio. By 2014, however, the share of corn in total planted acreage increased by 5 percentage points, up to 41 percent (Figure 3 below). Over a similar timeframe, U.S. Energy Information Administration (EIA) **data** shows the government-mandated surge in ethanol production: From 2008 to 2013, Ohio ethanol production soared by 45 percent.

"Environmentalists have always been rather skeptical about corn ethanol in general. Under ideal conditions, it provides a slight climate advantage over gasoline, but with only a small departure from best practices, that advantage evaporates. Corn needs fertilizer, and ethanol factories need energy, both of which typically come from natural gas. Finally, an ethanol mandate would increase the price of corn, which could spark new planting of corn in previously undisturbed areas, a process which releases huge amounts of greenhouse gases."

Ryan Cooper

"Time to kill the corn ethanol mandate." Washington Post, November 12, 2013.

Figure 3: Field Crop Shares of Acres Planted in Ohio, 2008-2014



When measuring the environmental impacts of expanding total corn ethanol production up to statutory RVO levels (15 billion gallons), or EPA-set levels, a lifecycle approach that encompasses land use changes (LUC) that occur throughout the entire process of ethanol production must be used. LUC is the conversion of land from native habitats or other existing cropland to cropland for corn. There are two types of LUC: direct and indirect. Direct LUC is the conversion of forest and grassland to cropland to provide feedstocks for biofuels production. Indirect LUC includes the price-induced market effects of farmers converting formerly unused areas to cropland for food production.

The study, "Climate change and health costs of air emissions from biofuels and gasoline," by University of Minnesota researcher Dr. Jason Hill provides an estimate of the total GHG and other major pollutant lifecycle emissions. Applying the **Hill study's** results along with Ohio's historical ethanol consumption, it is possible to calculate the aggregate GHG emission impact in Ohio over the past 10 years.

Based on that study and Ohio's state-specific data, the CRS study finds that corn ethanol production and consumption have added nearly 1.92 million metric tons of CO_2-equivalent (CO_2e) emissions in Ohio since 2005. These cumulative emissions are equivalent to the emissions of more than **398,000** cars in a single year, utilizing EPA **estimates** that point to the average car emitting 4.8 tonnes of CO2 per year.

Other potentially harmful emissions – VOCs, NOx, PM, SOx, and NH_3 – have also sharply increased in Ohio due to RFS-induced corn ethanol production and consumption. Controlling these pollutants is critical to meeting EPA's strict clean air standards.

Using the Hill study's lifecycle emissions numbers and Ohio ethanol consumption **data** from EIA State Energy Data System (SEDS), the CRS study calculates the cumulative, non-GHG related emission levels in Ohio from 2005 to 2014 that corn ethanol production and consumption have generated relative to gasoline. The results are shown in Figure 4.

Figure 4: Cumulative Incremental Lifecycle Criteria Pollutant Impact of Corn Ethanol Production and Consumption in Ohio between 2005 and 2014

(Calculated using the same data sources as the GHG analysis above - the Hill Study for incremental emissions and consumption from the EIA SEDS database)

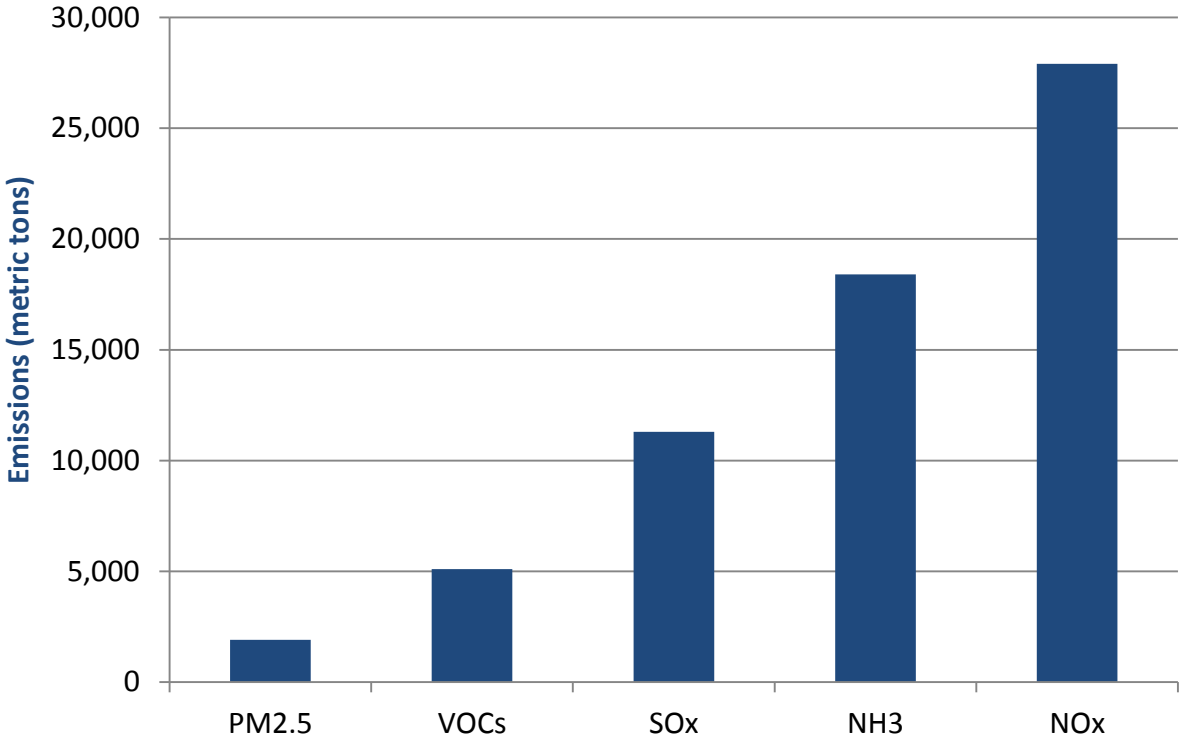


Figure 4 shows that corn ethanol production and consumption in Ohio have emitted approximately 5,000 tons of additional VOCs and 28,000 tons of additional NOx during the period of 2005 to 2014. Both NOx and VOCs are precursors that form ozone. The increased emissions of these pollutants are concerning given that EPA recently finalized a new ground-level ozone rule that tightens the standard to 70 parts per billion (ppb) from 75 ppb. This new lower level will thrust the majority of Ohio into **noncompliance**. Ironically, EPA's effort to clamp down on ozone precursors such as NOx and VOCs may end up being severely undermined by its support for adding additional volumes of corn ethanol to the fuel supply.

For Allen and Fayette counties, which both host ethanol refineries and would be out of compliance under the new 70 ppb standard, greater ethanol volume requirements could make ozone compliance even more difficult. Assuming the plants expand their production capacity to take advantage of EPA's higher volume requirement mandates, NOx and VOC emissions, as well as emissions of other pollutants, would increase.

Other Environmental Issues Related to Corn Ethanol

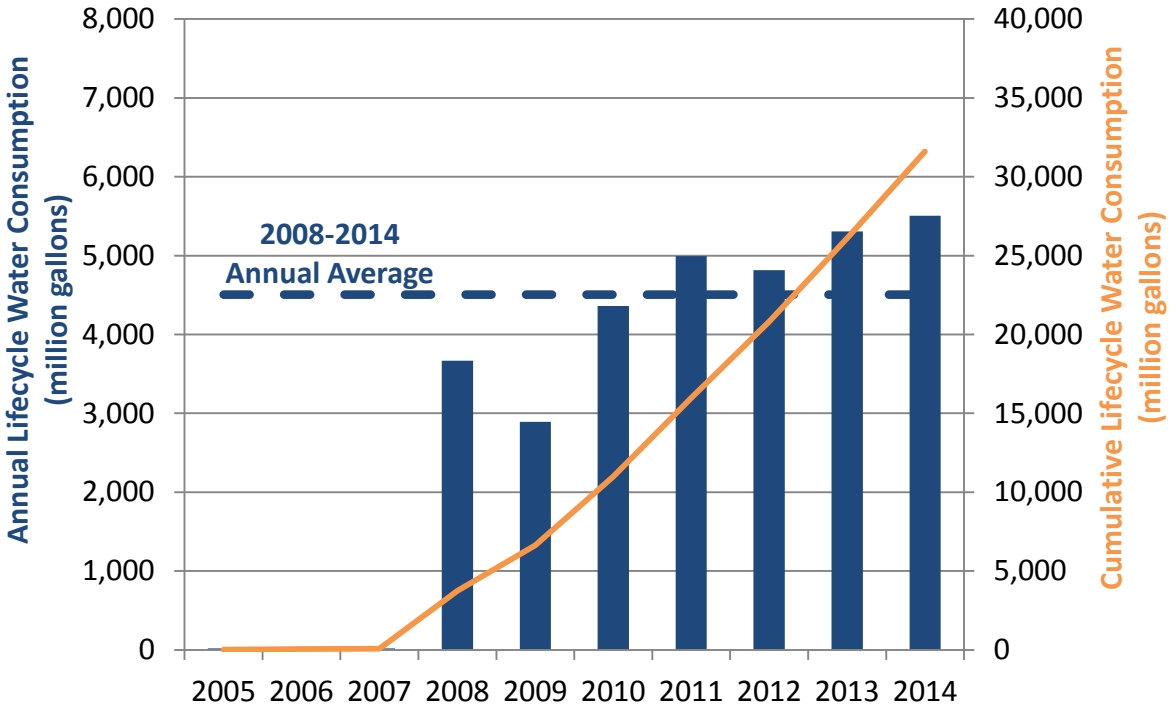
The corn ethanol mandate has contributed to a number of other environmental problems beyond just increasing major air pollutants. Other adverse consequences include significant increases in the amount of water consumed; increased soil erosion; greater use of fertilizer and other chemical components; and increased contamination of surface and groundwater bodies. Increasing the amount of ethanol that must be blended into the nation's fuel stock – which is what EPA is poised to do later this month – has the potential to exacerbate many environmental issues that could directly and severely impact Ohio in particular.

Water Consumption

While Ohio has traditionally been considered a "water-rich" state, the increase in corn and corn ethanol production over time has put a strain on the state's water supply. Corn is a water-intensive crop, and the amount of water needed to grow and produce corn over its lifecycle is not insignificant. A 2011 **study** produced by the Argonne National Laboratory estimates that it takes 11 gallons of water to produce 1 gallon of corn ethanol. A separate study from **Sandia Labs** suggests that irrigated corn can use more than 880 gallons of water to produce one gallon of ethanol fuel. Since the majority of Ohio's corn is rainfed, this analysis uses the more conservative numbers.

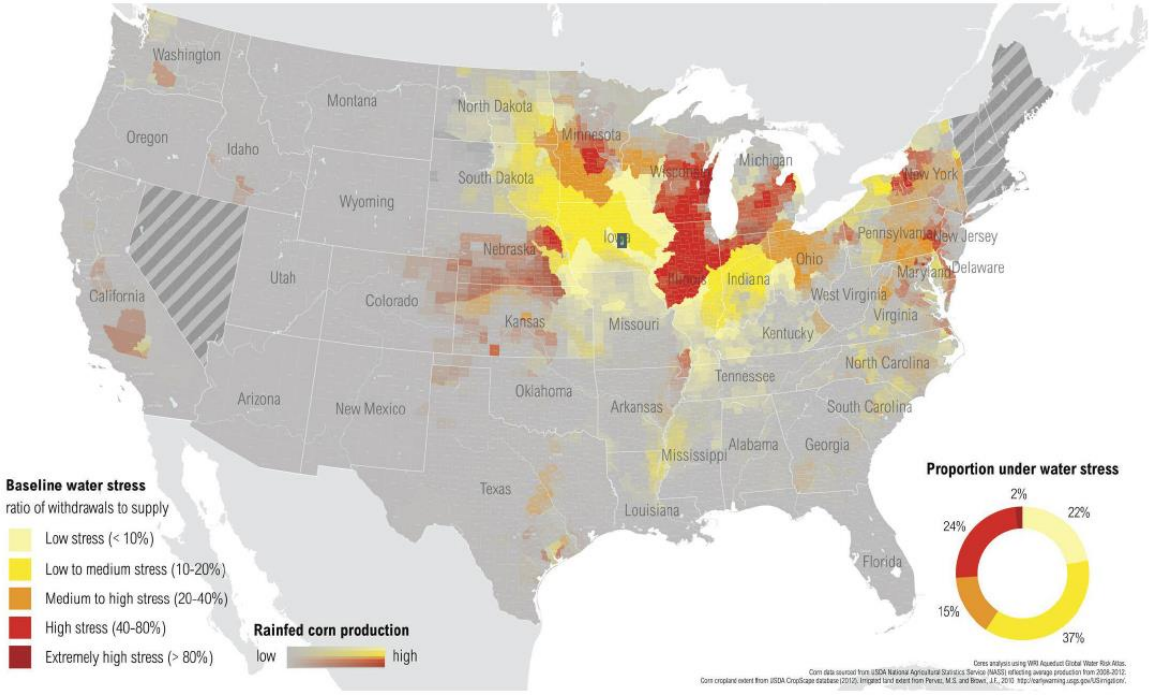
Given Ohio's **historical corn ethanol production**, we estimate that nearly 32 billion gallons of water were consumed between 2005 and 2014 (as shown in the Figure 5 on the next page). From the seven-year period between 2008 and 2014 (the period in which Ohio's ethanol plants have been operational), lifecycle water usage averaged over 4.5 billion gallons per year (or the equivalent of the yearly water consumption of over 48,000 households), according to the Ohio EPA's **2014 Sewer and Water Rate Survey**.

Figure 5: Corn Ethanol Production Lifecycle Water Consumption in Ohio, 2005-2014



This increase in water consumption owing to increased corn production could potentially strain the state's water supply, according to the findings of a recent Ceres **report**, which examined water risks associated with U.S. corn production. As shown in Figure 6 below, much of Ohio's landscape is under "medium" water stress (defined as a 20 to 40 percent ratio of withdrawals to supply). An increase in corn ethanol demand could further excerbate this status.

Figure 6: Map of U.S. Water Stress in Areas of Rainfed Corn Production



Red areas are regions where a large portion of existing water supply is already being used. Regions of rainfed corn production that face high water stress have less ability to switch to irrigated production should changes in climate lead to increases in irrigation demand.

Soil Erosion

The RFS artificially increases the demand for corn, which in turn has the effect of inflating corn prices. Given the opportunity to sell their crops at higher prices, farmers, not surprisingly, have shown a keen interest in increasing their corn production. As such, there is an increased risk of soil erosion and groundwater pollution that naturally comes from producing more corn.

The above graphic, taken from a Ceres **study** on water and climate risks stemming from additional domestic corn production, demonstrates the heavy water stress that is currently affecting Midwestern states, including Ohio. In fact, even **agricultural officials in Iowa** have noted that "high corn prices have encouraged expansion of row crop production to lands which often are at greater risk for soil erosion." As seen in the Figure 7 below, acreage previously protected under Ohio's Conservation Reserve Program (CRP) has decreased by more than 20 percent from 2008 to 2014, while the total corn acres planted have increased.

The CRP is a mechanism that encourages **landowners** to convert "highly erodible cropland and other environmentally sensitive areas to permanent cover, such as introduced or native grasses, trees, filter strips, riparian forest buffers, wetlands, and

shallow water habitats." In other words, acreage enrolled in the CRP program is acreage that does not erode and does not require chemicals and fertilizers to be applied. Landowners who participate in the program receive annual rental payments from the federal government and are provided cost-sharing assistance for up to 50 percent of the eligible costs — all for the purpose of protecting these lands from deleterious impacts of corn production.

Figure 7: Conservation Reserve Program Acreage Change in Ohio between 2008-2014

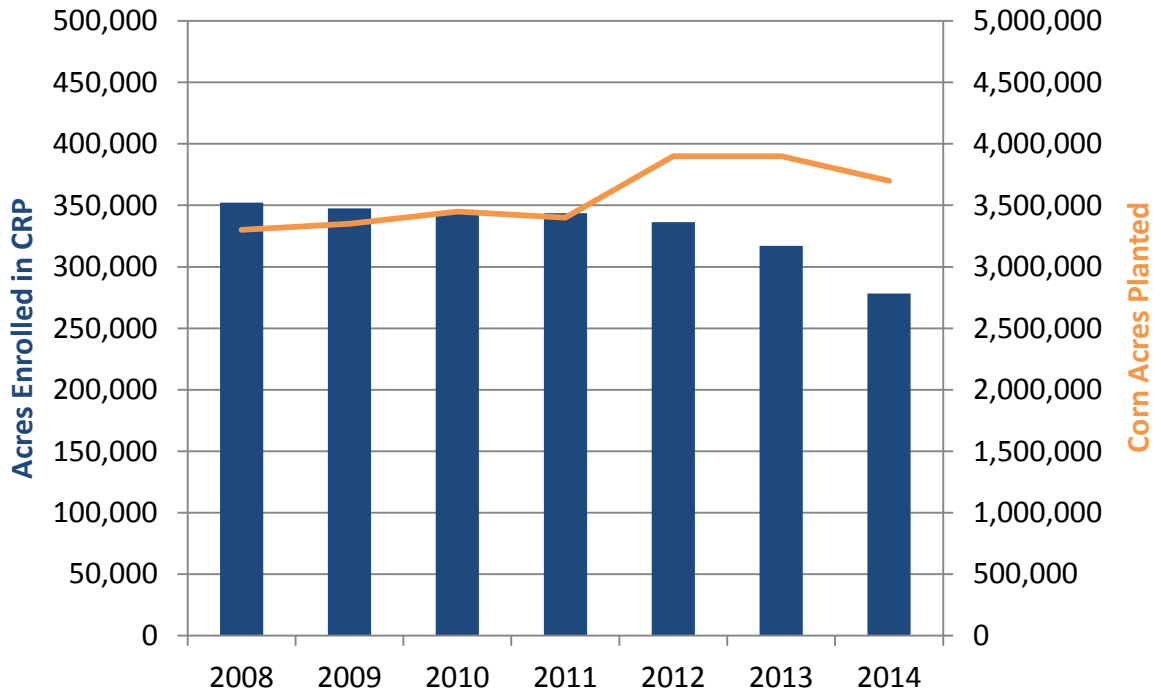


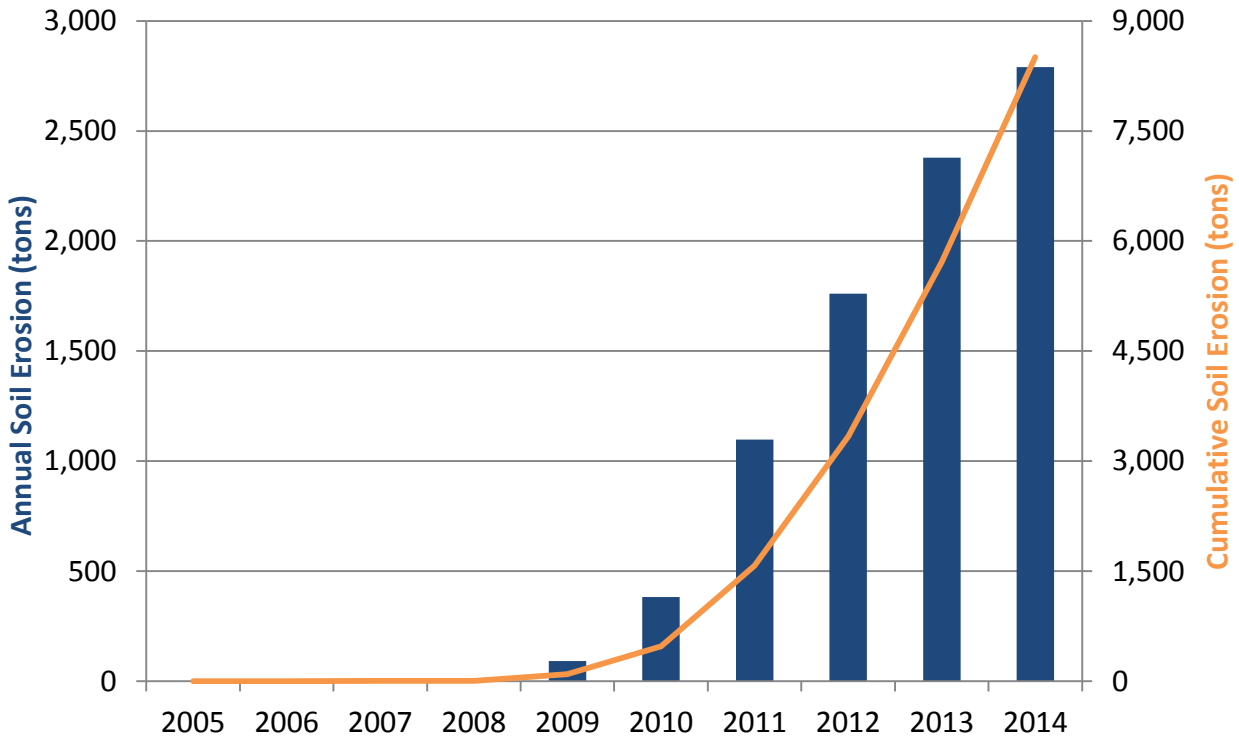
Figure 7 outlines the total number of acres on which corn was planted in Ohio, compared to the total acres enrolled in the CRP program, as captured by the USDA National Agricultural Statistics Service (**NASS**) and the Farm Service Agency (**FSA**), respectively.

Notwithstanding the fact that, under the CRP program, farmers are essentially paid to not grow corn, historically high corn prices spurred on by the RFS have forced many farmers to reverse tack and produce corn on CRP protected acreage anyway. The ***Journal of Environmental Engineering*** predicted this would happen, predicting in a 2010 study that "high demands for corn to produce ethanol would influence some producers to return those highly erodible conservation lands to corn production. Such conversion of sensitive CRP areas from protective vegetation to corn would potentially reverse water quality benefits of CRP lands."

Furthermore, as corn production increases, so too does the need for effective management practices to control soil erosion. The **U.S. Department of Agriculture** notes that "disturbing the soil through tillage and cultivation and leaving it without vegetative cover may increase the rate of soil erosion. Dislocated soil particles can be carried in runoff water and eventually reach surface water resources, including streams, rivers, lakes, reservoirs, and wetlands. Sediment is the largest contaminant of surface water…and is identified by States as the leading pollution problem in rivers and streams." However, environmental analysts have **estimated** that only "34 percent of U.S. corn acres are farmed using best practices for nitrogen fertilizer management."

Using data from the Policy Analysis System (POLYSYS) agricultural policy simulation model (De La Torre et al. 1998) that was employed in the **Univ. of Tennessee Study**, the CRS study finds that cumulative soil erosion in Ohio has increased by more than 8,500 tons due to the RFS mandate. This finding assumes Ohio encountered the same rate of growth as U.S. total soil erosion as a result of federal mandates and incentives to increase corn ethanol production.

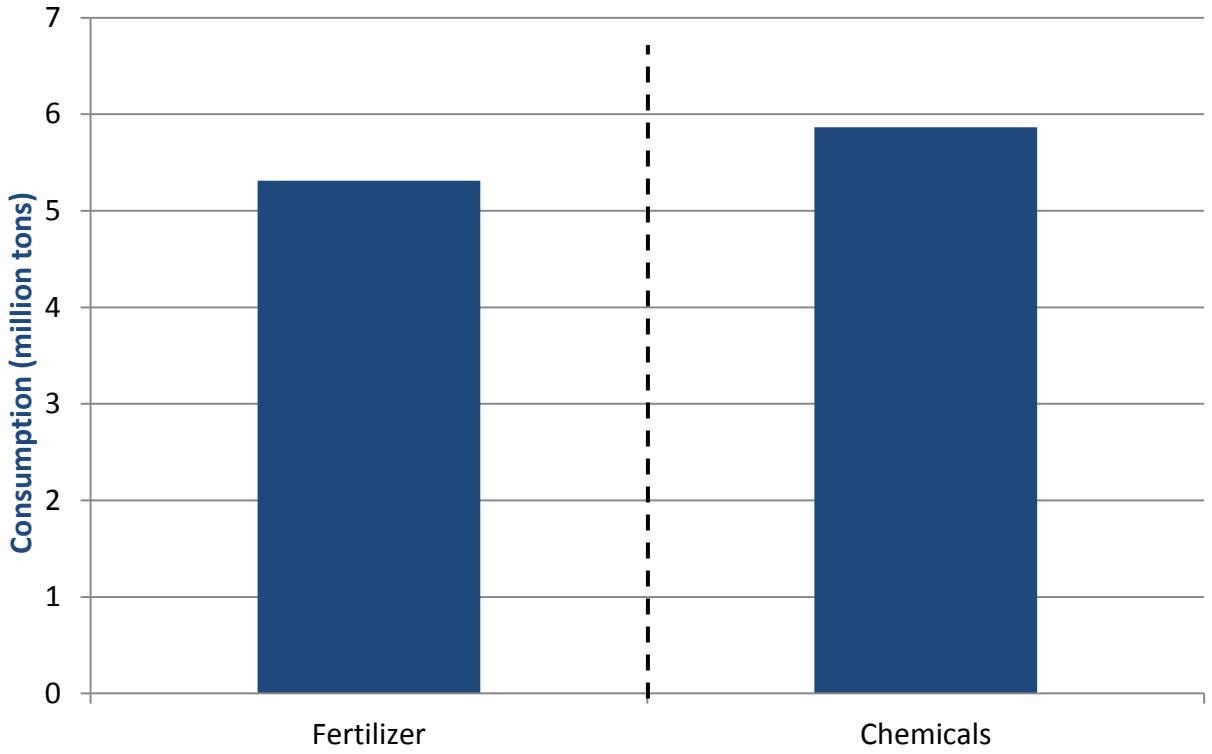
Figure 8: Incremental RFS-Related Annual and Cumulative Soil Erosion Associated with Corn Ethanol Production in Ohio



Fertilizer/Chemical Consumption

As more and more corn continues to be grown in Ohio to be sold into the guaranteed markets created and expanded under the RFS, the use and consumption of agricultural fertilizer and chemicals (i.e., the highest contributors to polluted surface and groundwater) have also grown significantly in Ohio over time. Figure 9 shows the change in annual fertilizer and chemical consumption in Ohio in 2014 due to RFS mandates.

Figure 9: Increased Agricultural Fertilizer and Chemical Consumption in Ohio in 2014 due to RFS Mandates



Ohio has already seen in practical, real-world terms some of the worst impacts of these agricultural practices, most directly in the algal blooms that occurred in Lake Erie, which polluted regional drinking water supplies. In fact, a 2013 **article** in the *Proceedings of the National Academy of Sciences* (PNAS) showed that "long-term trends in agricultural practices are consistent with increasing phosphorus loading to the western basin of the lake." Similar conditions made headlines in the ***Washington Post*** earlier this year.

These problems are not limited to Lake Erie. In fact, seven lakes, reservoirs and rivers that supply drinking water to approximately one million people in Ohio have repeatedly exceeded safe levels of a toxin related to algae that can cause sickness and liver

damage, according to a state **water quality report.** Toxic algal blooms could also threaten counties **along the Ohio River**, including Columbiana, Jefferson, Belmont, Monroe, Washington, Athens, Meigs, Gallia, Lawrence, Scioto, Adams, Brown, Clermont, and Hamilton counties. Additionally, communities along Lake Erie's Western Basin Shoreline will be impacted, including those in Lucas, Ottawa, Sandusky, and Erie counties. Other large lakes and reservoirs in Ohio will collect agricultural runoff, impacting parts of Geauga, Portage, Mercer, Auglaize, and Allen counties.

If EPA were to decide to increase the levels of mandated ethanol use as envisioned by Congress, more corn would be produced, more fertilizers and chemicals will be deployed, and Ohio will be put at even greater risk for the soil erosion, algal blooms, and related drinking water issues outlined above.

Conclusion

However well-intentioned President Bush and Congress were in offering up the Renewable Fuel Standard as a miracle solution to the nation's energy, environmental and security challenges a decade ago, real-world experience and data acquired over the intervening years and now better understood have proven that the RFS has not produced the results we were promised. Moreover, the RFS serves as a millstone around the necks of small businesses struggling to compete and survive in an uncertain economy, and comply with numerous environmental mandates.

With the benefit of hindsight, we now know that the RFS has not contributed to a better environment and cleaner air and water – it has made each of these things far worse. Producing ethanol from corn, which was sold as a temporary transition step necessary to get to a future in which ethanol would be made from materials like switchgrass and waste, remains the dominant production pathway and source for the overwhelming majority of ethanol used today, especially as advanced biofuels have failed to reach commercial scale. Despite all this, EPA is actually considering a final RVO plan that would increase the mandated levels of ethanol that consumers are compelled to use, notwithstanding the clear environmental and economic costs that such a policy would engender. The corn ethanol mandate has so far cost Ohioans $4 billion in additional transportation fuel costs, which resulted in $4.8 billion in lost GDP, $2.7 billion in lower labor income, and the equivalent of 5,500 lost jobs per year.

As it relates to those environmental costs in particular, Ohio stands to be among the states most severely impacted under a scenario in which ethanol production and use continues to be expanded. As described in this study, the RFS has had the effect of increasing the production and output of GHGs by 1.92 million metric tons of CO_2-equivalent (CO_2e). It is responsible for the output of approximately 5,000 additional tons of VOCs and 28,000 tons of additional NOx in Ohio from 2005 to 2014. And it has

claimed over 32 billion gallons of water that, were it not for the RFS, would not have been consumed.

Scientists have been warning of these consequences since before the mandate was even codified; the political class in Ohio and elsewhere is now listening. As one of the states that has the most to lose under an expanded RFS policy, Ohio should insist that the EPA fundamentally reform the ethanol mandate before it's too late. Now is the time to act.

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