

The Corn Industrial Complex

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By

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On my honor as a University student, I have neither given nor received unauthorized aid on this
assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Since 1995, the United States has provided \$116 billion dollars in corn subsidies, \$68 billion dollars more than the next highest subsidies, wheat (Hayes, 2021). This massive disparity in corn subsidies underscores the fact that corn is the most produced and most consumed product in America (USDA, 2022). While corn is the most heavily subsidized crop, approximately 10% of the corn grown is consumed by humans. The majority of corn produced is used as animal feed, approximately 39%, with the second largest consumer of corn being corn ethanol. Corn ethanol makes up 34% of domestic corn consumption, as it is mandated to be blended with gasoline. With the United States exporting 17% of their total corn grown, this leaves a meager 10% for domestic consumption.

This massive demand for corn in the form of fuel and feed stock means that there is little corn left for consumers, and much of the corn consumed is in the form of sweeteners or cereals. These subsidies act as a means to reduce risk for the farms, as they know the price that the corn will sell for before they plant. While this massive subsidy system has led to more corn growth than any other plant in the United States, it has negatively impacted the American people in a number of ways. The use of corn sweeteners has negatively impacted the health of the average American, who face health concerns and heart disease. Americans specifically have seen a spike in obesity that directly correlates with corn production, indicating that the more corn produced is not being put to good use. The increased demand for corn has also caused the average price of corn to increase, meaning more expensive meals and an increased consumption of cheaper “fast food” alternatives. This market basket price increase caused by corn demand has caused poultry and bovine products, two industries dependent upon corn for their feed supply, to increase in

price. Furthermore, the ethanol blending mandate has caused more corn to be used for corn ethanol, further impacting the climate. Increased corn production, specifically for ethanol, is directly attributable to thousands of deaths per year, and cascading environmental impact on millions. This paper will explore the interconnection of corn subsidies, intended to increase the security of the farmer, on American's Health, commercial food prices, and the environment.

Corn and Public Health

The majority of this 10% of corn is used for sweeteners, being turned into high fructose corn syrup and other sugar blends that are used to sweeten existing projects. With 15.1 billion

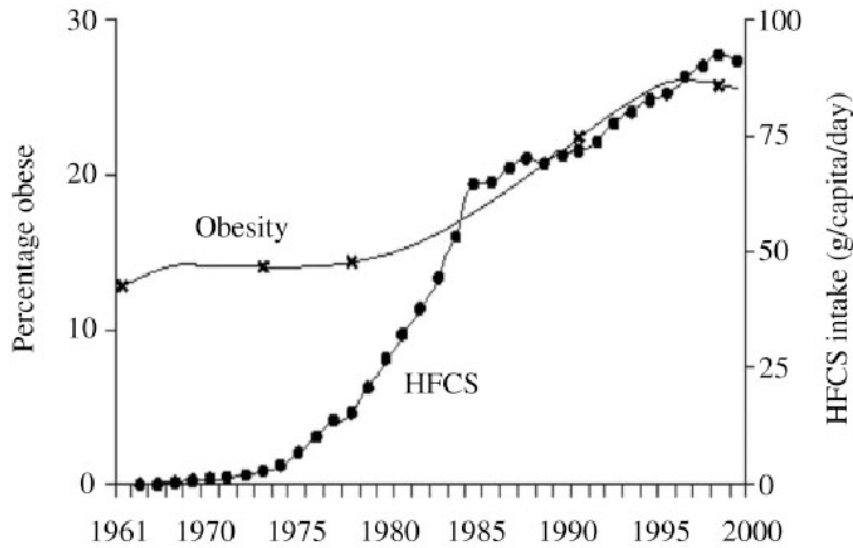


Figure 1: HFCS consumption from 1961 to 2000, compared to the American Obesity percentage, adapted by Riley Peterson (2021), from Klurfeld, D. et all (2013).

bushels of corn being grown in 2022, this means that approximately 845 million bushels of corn are being turned into sweetener or syrup products. There is significant correlation between the increase of

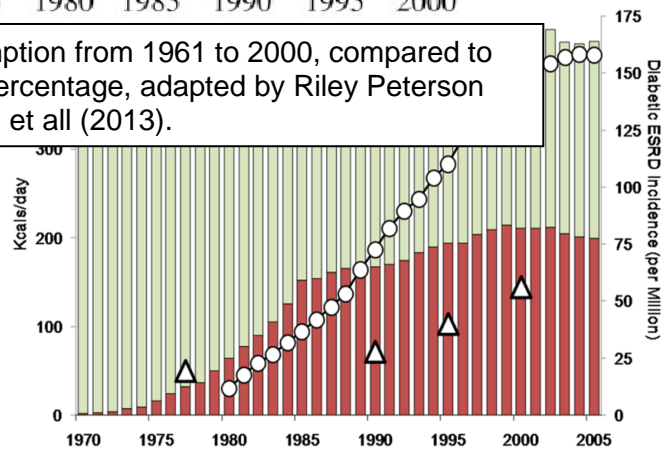


Figure 2: Cases of new diabetic diagnoses per million compared to rising consumption of High Fructose Corn Syrup from 1970 to 2005, adapted by Riley Peterson (2021), from Shoham et all. (2008).

corn syrups in foods and the increase in obesity, specifically since the introduction of high fructose corn syrup, or HFCS. This corn syrup is chemically dense in sugar and starches, and as a result contribute to weight gain (CDC, 2019). The reason behind this is that fructose is a different sugar structure than sucrose, and as such is metabolized differently. This leads to increase liver fat and decreased ability to process blood sugar. The increase in blood sugar builds up a sugar dependence, where the body adjusts to high levels of sugar and in turn demands a high blood sugar level. This demand for high blood sugar, coupled with an overuse of the pancreas and an inability to produce insulin, causing obesity and an increase in Type II diabetes (Kulfiel et al, 2013). As seen in figure 1, the obesity in the United States begins to rise when the amount of high fructose corn syrup in the diet increases. This trend started around 1980, as indicated by the graph, with the addition of high fructose corn syrup into soft drinks and other sweet items. This cheap sweetener slowly integrated itself into common food items, eventually becoming the most common added sweetener by 1985. This large demand was just a combination of cheap cost and high potency as a sweetener; however, it was detrimental for the American public. In addition to the increase of obesity, diabetes saw a similar spike starting in 1980. As seen in figure 2, the rate of diabetes increases, starting similarly to the introduction of HFCS into the American diet. These two trends indicate that HFCS was negatively impacting both the weight and health of the American people, and while there are other contributing factors, the impact cannot be overlooked.

Corn and Fuel Demands

In 2005, the United States found itself fighting a “War on Terror” across the Atlantic, with the primary opposition being major suppliers of US oil. To continue this prolonged war

would lead to price inflation of US commodities, specifically oil and gas, and this is something that the American people loathe. During the 2004 election cycle, George Bush made numerous promises to reduce gasoline prices, and his first attempt to do so was the Energy Policy Act of 2005 (Holt, 2006). This mandate required that an increasing number of renewables be added to gasoline to reduce the reliance on foreign suppliers. This initial requirement blended 400 million gallons of ethanol with gasoline, rising all the way to 36 billion gallons in 2022. Corn derived ethanol makes up 95% of all ethanol produced in the United States. It is primarily used as a fuel blend with traditional gasoline, with current fuels mandated to be a blend of ethanol and gasoline, with a minimum threshold of 10% ethanol by volume, commonly called E10 (Economic Research Service, 2021). The purpose of fuel ethanol is to both improve the performance of engines and reduce tailpipe emissions that negatively impact the environment. Ethanol inclusion in fuel is also meant to reduce the United States dependence on foreign energy providers, and since the passage of the Energy Policy Act in 2005, foreign oil imports have decreased 36% from 2005 until 2019 (Energy Information Administration, 2019). While this energy drop cannot be whole attributed to the use of ethanol, the Renewable Fuel Administration estimates that net petroleum dependence would be 10% without ethanol production, currently 4% (Renewable Fuel Administration, 2021). This massive demand for ethanol has created a massive demand for corn, where the total amount of corn in the United States has grown to 15.1 billion bushels in 2022. This corn supply is still not enough to satisfy all corn hungry parties, and corn reserves and supply is expected to continue to grow, as the subsidies for corn persist.

Corn Economics

In the United States, subsidies provide an incentive for farmers to grow corn, specifically providing a price floor for corn prices per acre of corn. These subsidies allow farmers to grow corn without fear of the volatility of the agriculture market causing them to lose money on their products. Corn is currently subsidized for \$1.95 per bushel, which means that the minimum a farmer would receive for his bushel of corn would be \$1.95 (Energy Information Administration, 2019). The idea behind these subsidies was to protect and help American Farmers and consumers who would be hurt by fluctuation in corn prices. In 2002, the passage of the Farm Bill Act re-enforced food security in the United States by setting these price floors for crop yields, with the intended purpose of reducing the United States' dependence on foreign aid for food. This policy of American food resilience led to \$20 billion in aid being allocated for farm subsidies (Babcock & Fabiosa, 2001). This complex agriculture environment is where corn demand exists, and is pulled between the consumption demand of the people and cars. The practical, and executed,

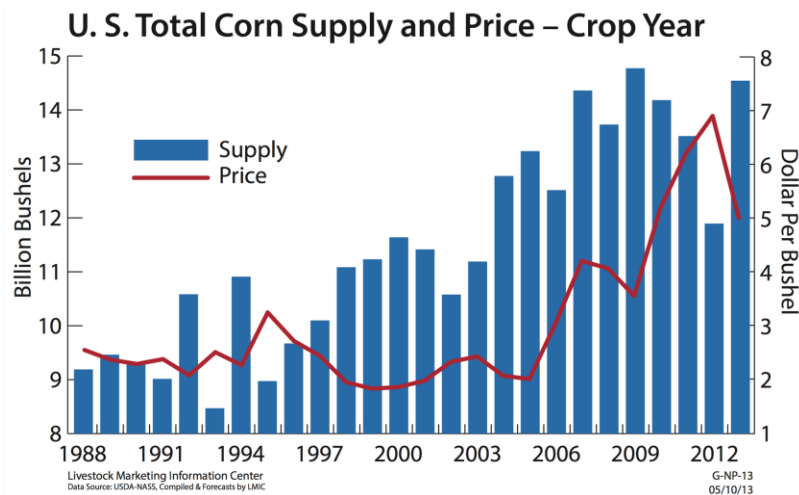


Figure 3: Total U.S. corn supply and retail price per bushel from 1988 to 2013, adapted by Riley Peterson (2021), from Childs (2013).

solution is to grow more corn, and this is exactly what is done. From 2002 to 2020 there has been a linear increase in corn production of about 2 bushels per acre per year. This may seem small, but with over 90 million acres of farmland dedicated to growing corn, this is a staggering

increase in efficiency (Kucharik, 2005). Figure 3 shows that corn per acre has steadily increased in the United States since 2000, as well as the price of corn during that time period. The price of corn has risen dramatically in correlation with the amount of corn produced, which according to basic economics should not be the case. When there is an increase in supply, price drops, yet in the case of the American corn price, supply increase has led to price increase. This is because American corn consumers are competing with fuel mandates and agriculture demands, and as such there is not enough corn to go around.

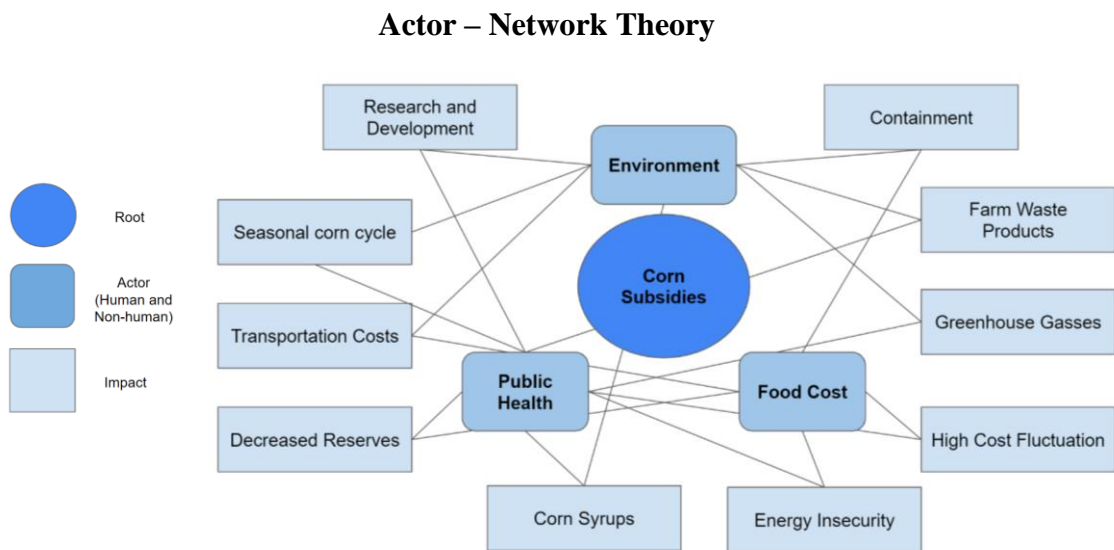


Figure 4: Actor Network Framework for corn ethanol production. Identifies the impact of corn ethanol production on both human and non-human actors. (Peterson, 2021)

The actor network surrounding corn subsidies is complex, but by examining the web of interactions surrounding the subsidies, the impact of change can be measured. As seen in figure 4, the actor-network centered around corn subsidies impacts 3 major categories, the environment, public health, and consumer cost. These categorical changes will be examined before 2005 and after 2005, when ethanol blending became mandated. This change dramatically increased the demand for corn, and altered the buying and consumption landscape. The controller of corn

subsidies is the federal government, and the price is determined by the farm bill, which is renewed every five years to account for price fluctuations. This means that the price that corn is bought and sold at represent a market that is five years old, and energy demand regulations that are updated yearly. The volatility of this market makes it especially difficult on consumers, who have experienced a raised corn price since 2005 as shown by figure 3. Much of the fuel mixing support for ethanol stems from the argument that ethanol is helpful for the environment, and this theory is only partially correct. The actor-network will examine the relationship between the environment and ethanol blending, especially how this blending mandate impacts the actor of corn subsidies. The Framework in figure 4 demonstrates the complex web that exists between corn ethanol in fuel, corn reserves for consumption, and complex corn sugars being consumed at an increased rate.

The Obesity Correction

While studies have shown time and time again that obesity and heart disease are related to HFCS consumption, the American people reached a breaking point in 2005. In 2005 there were 1.5 million new diagnoses of diabetes in adults aged 20 and older according to the CDC (CDC, 2012). In addition, the average American consumed approximately 60 pounds of HFCS a year according to the US department of Agriculture (Agriculture, 2021). Analytical research conducted by the US department of Agriculture indicates while the trend of obesity in the United States has directly increased over the last 2 decades, there is a clear correlation between obesity and corn demand. Statistical analysis shows that while there is a positive correlation between food price and obesity, there is also a negative correlation between fast food prices and obesity (Reddy, 2012). The idea is simple, healthier foods are on average more expensive and less

calorie dense when compared to unhealthy food. There exists a relationship, between each point the relative price index of food increases, which is the cost of a sample of healthy foods divided by unhealthy foods, the obesity population will increase too by 41.7%. This is an absolute

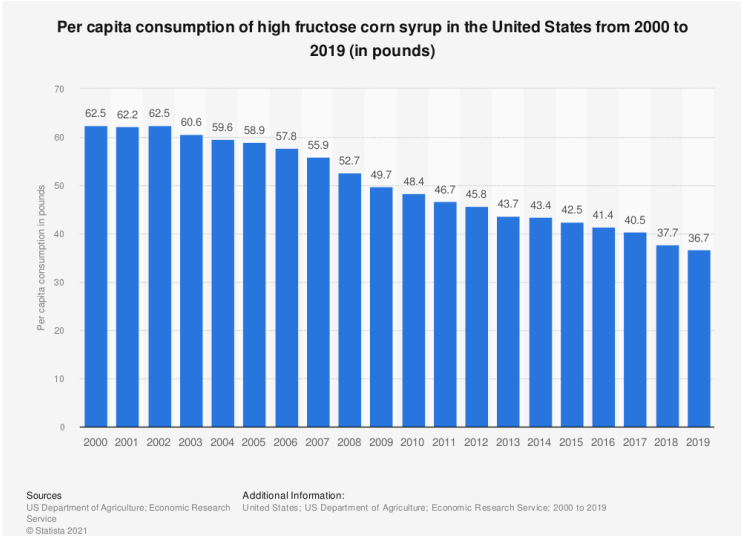


Figure 5: Reduction of High Fructose Corn Syrup from 2000 to 2019, adapted by Riley Peterson (2021), from US Department of Agriculture (2021).

startling correlation, that if the price of healthy foods increases by twice as much as the price of unhealthy foods, then the obesity population will grow by 50%. However, this trend has been heading in the opposite direction recently, since the corn ethanol mixing mandate in 2005.

The relative price index of food has decreased since the New Energy Policy act of 2005, and as such the relative growth of obesity in the United States has shrunk. This has much to do with the relative price of corn and corn sweeteners. In the late 1900s the use of corn syrups skyrocketed because of the relatively cheap price. Since 2005 however, corn has been more expensive, and this has impacted the American people in two ways. The first of which is a decrease in HFCS consumption and integration in modern food. As shown in figure 5, the average amount of HFCS has decreased linearly since 2005, and as the demand for corn has increased for ethanol, the use of HFCS has decreased. This astounding trend suggests that the production of corn ethanol has helped decrease the use of corn syrups as a sweetener, and as such

limited the growth of obesity in the United States. The corn subsidies have supplied a constant price structure for corn sales, which allowed corn supply to slowly grow while meeting the agriculture and consumer demand. With the ethanol demand supplanting the consumer market, the corn sweetener market dried up as corn price increased. This has led to a healthier consumer as the decrease in corn syrups correlate to a decrease in obesity rates. The impact that the actor, corn subsidies, has on obesity, is direct and meaningful. As highlighted above, the obesity rate in America has decreased since 2005, which means that less people are getting fat per year than they were in 2005. Corn subsidies were implemented in the early 1970s, and as show in figure 1, this is when the HFCS epidemic began. The plentiful nature of corn in the late 20th century forced entrepreneurs and industry titans to adapt their staple sugars to incorporate the cheaper corn sugars, and as such, obesity and diabetes increased. The corn subsidies were intended to keep farmers producing a crop that was not economically feasible to grow, costing a dollar more to grow than to sell per bushel (Cheng, 2022). These subsidies placed the American consumer at risk by forcing food manufacturers to implement this plentiful cheap corn, and the method they choose was HFCS. This obesity and diabetes trend has been curtailed with the introduction of the new energy bill in 2005, but there is still a massive demand for corn sweeteners, and as often is the case, the harm was already done.

Expensive Corn

The price of corn has increased by more than 400% in less than ten years, and burden for this price hike rests on the shoulders of corn ethanol. In an attempt to show that corn subsidies have no direct impact on rising corn prices, economists Babcock and Fabiosa have shown there is more than significant evidence pointing to the influence of ethanol production on corn price.

As shown in figure 3, the ethanol mixing mandate passage, 2005, directly correlates with the linear increase in corn price, and this corn price increase has then decreased the supply of HFCS as argued previously. This network of actors is impacted directly by the increase in ethanol blending, as the combination of high demand and low-cost corn has decreased the surplus supply substantially. The current corn market is saturated, with the retail consumer paying through the nose for a bushel of corn, which currently retails at a staggering \$7.76 dollars, which equals an all-time corn high, the other time being in 2012 when there was a major US drought (Corn Watch, 2022). The largest downside to this increase in corn cost is that it impacts the meat industry, and this cost hike is passed on to the consumer through many different items. As mentioned previously, approximately 40% of corn is used for animal feed, as it is historically cheap and nutrient rich. This means that when corn prices increase, it increases feed costs for bovine, poultry, and swine, or the main American staple proteins. The effect of the increased corn prices can be seen in an increased meat inflation rate. MIR, or meat inflation rate, is the measure of the price of 4 types of meat, chicken breast, New York strip steak, pork chop, and ground beef, compared to the prices a year ago (meat price inflation, 2022). This is how basic market basket price indexes are calculated; however, MIR is specifically for meat. When compared in 2021, the CPI, consumer price index, which is the measure of total inflation over a wide range of tracked items, rose 7%, compared to 12% for the Meat Inflation rate (U.S. Bureau of Labor Statistics, 2022). This spike correlates with the spike in corn prices, which have increases doubled from \$3.16 in April 2020 to \$6.87 in April 2021 (meat price inflation, 2022). This complex actor network interaction demonstrates how ethanol mixing demand has not only increased the price of corn, but has increased the price of other food items. This unforeseen implication demonstrates that as corn prices increase, so too will complex food items and

proteins that rely on corn grains as feed stock. While corn use in ethanol has limited obesity growth, the increased price in proteins counteracts much of the good will ethanol mixing has carried.

Ethanol Blame Mixing

Much of the benefit of ethanol mixing is derived from the environmental benefit supposedly provided. The argument for the positive environmental impact of ethanol in fuel is that the fuel source, corn, absorbs CO₂ as it grows, and then contributes CO₂ when it is burned. This creates a supposed net neutral, as the tailpipe emissions are reduced by the absorption of corn (EIA, 2019). The problem with this tailpipe to crop analysis is that it doesn't include the full scope of CO₂ emissions. The first instance of CO₂ emissions stems from the production of ethanol, which is carried out using fermentation. Fermentation is the process of using yeast to break down sugars in the corn to produce alcohol. As ethanol is alcohol, this beer slurry is then run through distillation columns, where the impurities are removed and 100% alcohol remains. The problem with this process of ethanol production is that fermentation produces CO₂, and not just a small amount of CO₂. The rule of thumb for ethanol production dictates that for a bushel of corn, a third of the product turns into animal feed stock, a third turns into ethanol, and a third turns to CO₂ (Dunn, 2013). This massive CO₂ expenditure is not factored into the environmental impact calculations, and rather than presenting ethanol as carbon neutral, it is strongly carbon negative (Lark, 2022). The difficulty with this issue is that the use of corn as the ethanol production staple has forced farmers to further pursue land efficiency, and as shown in figure 3, the corn supply has increased dramatically with minimal increase in growing acreage. These advancements in corn growing efficiency, something that is greatly desirable due to subsidies on corn dictating that all corn grow can be sold for a profit, have negatively impacted rural water

supplies and land quality (Lark, 2022). An increase in precision farming, the practice of farming where soil variables are tracked and measured to increase farming efficiency, has led to an increase in usage of direct nitrogen injection, which has been shown to directly impact local flora and fauna (Ferris, 2004). These are more pressing impacts that are not directly calculated into the

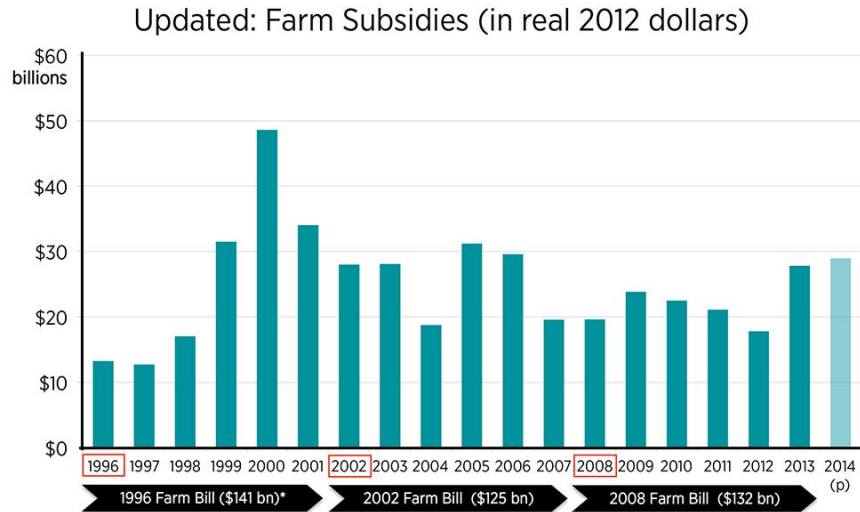


Figure 6: Farm bill spending on crop subsidies from 1996 to 2014, adapted by Riley Peterson (2022), from OMB (2014).

tailpipe neutral equation, and are the result of increased subsidies for corn and a pursuit of efficiency. The land has also been impacted with the pursuit of efficiency, and many farms have maximized short term yields over long-term productivity, which again is a form of land destruction (CQ.com, 2014). If the future viability of the land to grow crops is reduced in an attempt to reach short term yield thresholds, this will harm the American economy in the long term, and destroy the surrounding ecosystem. This short term returns approach again is a perk of the corn subsidies system, where the specific corn price for the subsidy is set at the beginning of the year, without price security assured for the future. While the infrastructure of the farm bill will ensure that corn subsidies don't disappear, the specific commodity price fluctuates heavily year to year, and for this reason, farmers will determine to grow or let their fields lay on fallow. As seen in figure 6, the next year corn subsidies are not known, and as such farmers are pushed

to maximize short term profits, as the subsidy program may be reduced or disappear entirely. This lack of long-term profit security leads farmers to operate under year over year stress, where their livelihoods are dependent upon continuous passage of farm bill acts. This ignorance of future price guarantees forces farmers to operate year to year for their crops, rather than in long term ways that could potentially be helpful for their farm and the ecosystem (Auernhammer, 2001). The downside of these corn subsidies for the environment is that they force farmers to take short term perspectives as they may be forced to grow a different crop the next year as the existence of the corn subsidies is not guaranteed. This fast-farming approach has contaminated water systems and damaged ecosystems, as well as generated massive amounts of unaccounted for CO₂ emissions through the production of ethanol. In fact, it is estimated that 4,300 premature deaths can be attributed to growing corn each year. A study conducted by Nature Sustainability concluded that almost five thousand deaths a year could be traced to common corn growing practices, specifically the production of pollution called PM 2.5. These pollutants are classified by size, and PM2.5 are particles that are on average 2.5 micrometers in diameter, and are directly linked to cardiovascular problems, respiratory illness, diabetes and even birth defects. Furthermore, the largest contributor of PM2.5 is farming activity, contributing 16% of all generated PM2.5. It was concluded that the majority of PM2.5 generation that stemmed from corn farming was attributable to the fertilizer used, a combination of nitrogen and ammonia (Hill et. all, 2019). The actor of corn subsidies has created an economic monster that is consumed with short term corn production and efficiency, which has in turn impacted the land and subsequent water systems that supply the farms. The usage of ethanol in engines as a means to reduce emissions is misguided, as the production of ethanol produces more ethanol than is released through transportation.

Conclusion

In conclusion, corn subsidies were implemented in the 1970s as a measure to stabilize US food markets and increase domestic food security. By all accounts, these goals were met with flying colors, as the amount of corn in the US has grown from 4 billion bushels of corn in the 1970s to 15 billion bushels of corn in 2022 (Smith et al., 2022). This massive success of corn growth has had a number of unintended impacts on the American people, and the environment. The increase of cheap corn as a result of the subsidies gave rise to an obesity epidemic, caused by a massive increase in high fructose corn syrups and their consumption. This trend was reversed in 2005, with the passage of the Energy Policy Act, which mandated the mixing of ethanol with gasoline to become the fuel that we use today. This sudden spike in corn demand increased the price of corn so much so that high fructose corn syrups were no longer a cheap sugar substitute, and saw the rate of obesity decrease. This win was short-lived however, as the increasing corn prices were passed along to consumers, where the price of staple foods such as beef and chicken increased as a result of increased feed prices. This ethanol price competition continues to impact food prices, as ethanol subsidies ensure that ethanol production remains profitable, while the free market has dictated that corn-based products and meat from animals that feed on corn have to increase prices accordingly. To meet all of the corn demand, farmers have implemented increasingly more environmentally harmful practices in order to boost corn yields. As a result of the volatility of the corn subsidy system, farmers are increasingly choosing to adopt precision farming techniques that maximize corn yields, while worrying very little about how these practices impact the ecosystem. The goal of ethanol mixing is to reduce carbon emissions, but a failure to evaluate the full scope of ethanol production and consumption has led

to large scale CO₂ emissions, and farming best practices have increased nitrogen concentrations on proximate streams and ponds. These unintended consequences of corn and corn ethanol demonstrate the complex network that exists between corn subsidies, the American people and the environment.

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