Ethanol Blended Fuel: Information for Oregonians

In 2007 the Governor of Oregon signed HB2210. HB2210 requires that once 40 million gallons of ethanol production capacity is in service in Oregon, that after 90 days or a schedule determined through rulemaking, all gasoline sold in the state must contain 10% volume of ethanol. The eastern side of the state will be the last to be phased into ethanol blend on 16 September 2008. In addition, HB2210 requires that all diesel fuel (except marine, locomotive and heating oil) must contain 2% volume of biodiesel, once 5 million gallons per year capacity is in service for 3 months using Pacific Northwest feedstocks. Substantive misinformation is available to Oregonians regarding the impacts and benefits of this policy. The following addresses some of the areas of concern regarding corn based ethanol.

Influence of Gasoline and Ethanol Cost and Price on the Economy

Americans spent some $312 billion on about 160 billion gallons of gasoline in 2006. In 2007 they spent $526 billion for roughly the same amount of gasoline use. The forecast is for some 155 billion gallons of gasoline demand in 2008 with an annualized average cost of $3.89 per gallon for a sum of $602 billion dollars.

Between 2006 and 2007 the increased cost for gasoline alone was $214 billion. In that same time some 5 billion gallons of ethanol were produced at market costs around $3 per gallon for a sum of $15 billion. In 2007 U.S. corn produced for food increased, corn produced for animal feed increased, exports of corn for feed and food increased.

The increase in the cost of petroleum in 2007 alone is 14 times more than the entire cost of ethanol production in 2007. That difference does not account for the additional cost savings off displacing more expensive gasoline with ethanol. We are looking at a doubling in gasoline cost between 2006 and 2008.

Corn Acreage and Production

Total US crop acreage peaked at 360 million acres in 1981. Since then, the number of acres planted for crops has gradually declined to 319 million acres in 2006, thanks to the Conservation Reserve Program (CRP) and other US Department of Agriculture (USDA) environmental protection programs. In 2007 approximately 80 million acres of this farmland was in corn production.

The 2007 corn yield was 13.074 Billion Bushels, up from 11.152 Billion Bushels in 2006. (National Corn Growers Association) A 14.7% increase.

	1998		2006		
	Bushels (billion)	Percentage	Bushels (billion)	Percentage	
Animal Feed	**6**	**61**	**5.6**	**50.2**	
Exports	**1.77**	**18**	**2.1**	**18.8**	
Ethanol	**0.59**	**6**	**2.1**	**18.8**	
Sweeteners	**0.59**	**6**	**0.753**	**6.8**	
Others	**0.885**	**9**	**0.591**	**5.3**	
Total	**9.836**		**11.152**		
Other category includes: Starch, Industrial, food, cereals, snacks, chips & alcoholic beverages					

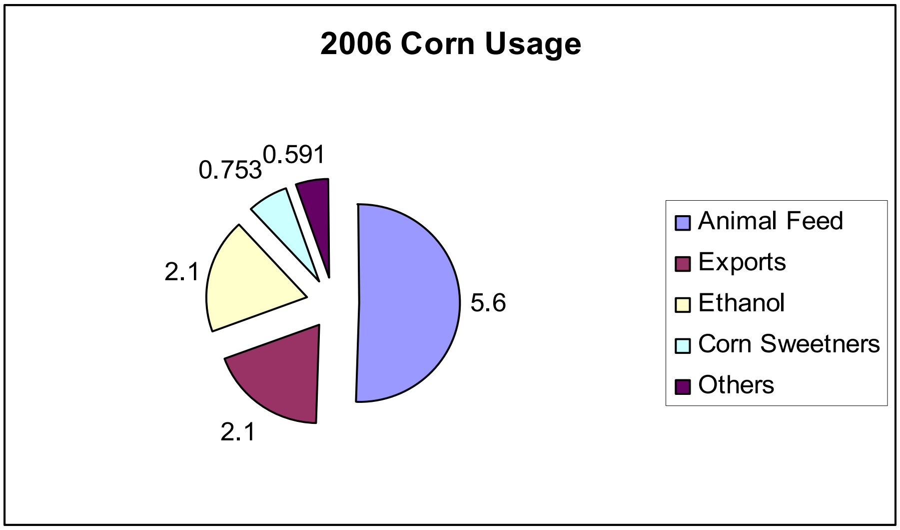
Corn Yields Are Increasing Per Acre

It is worth noting that while corn ethanol production increased almost 30-fold between 1980 and 2006, the number of corn farming acres held steady—at around 80 million acres. One major reason is that the corn yield per acre has steadily increased. Over the past 100 years, the US corn yield *per acre* has increased nearly eightfold (Perlack *et al* 2005). However, the increase in per-acre corn yields before the 1970s resulted from increased application of chemicals, especially nitrogen fertilizer, to corn farms. While the high chemical inputs during that period helped increase per-acre corn production, they did not help corn yield per unit of fertilizer input.

However, since the 1970s, the increase in the corn yield per acre has been achieved as the result of an increase in corn productivity through better seed variety, better farming practices, and other agricultural measures.

The US has 938.28 million acres of farm, pasture and ranch land according to the 2002 Census. Of this 434.16 million acres are considered cropland.

The 2007 corn crop came in at an average of 151.1 Bushels per acre (National Corn Growers Association). The 1998 crop came in at 9.836 Billion bushels at an average of 133.3 bushels per acre, 3.2 billion bushels less than 2007.



From Iowacorn.org, units in billion of bushels

Because sweetener, starch & alcohol production does not use the whole kernel, bushels that went into these products also provided animal feed & corn oil. Corn oil can be made into biodiesel.

Most Corn Is Animal Feed and Ethanol Dried Distillers Grains Adds Feed

- In 1998 animal feed consisted of 61% of the yield or 6 Bbu of corn.
- In 2006 animal feed consisted of 50.2% of the yield or 5.6 Bbu of corn.
- 1 Bushel = 15 lbs of animal feed or 2.8 gallons of ethanol and 18 lbs of DDGS (Dried Distiller Grains).

1998 = 90 billion lbs feed + 10.62 billion lbs DDGS = 100.62 lbs of animal feed
2006 = 84 billion lbs feed + 37.8 billion lbs DDGS = 121.8 lbs of animal feed
A 17.4 percent increase in total animal feed in a six year period.

Corn Exports Are Up

Exports increased by 330 million bushels or 16 percent. The worlds increased consumption of meat is the prime reason for the growth in the feed and export categories. If this trend continues we need to develop digesters at a much faster rate.

As of Jan 2008, the US has an ethanol production capacity of 7.229 Billion gal/yr of ethanol (RFA), almost half of the 15 Billion gallons of corn ethanol required by the Energy Independence and Security Act of 2007 (EISA) for 2015.

At a conversion rate of 2.8 gallons per bushel (many sources, RFA, NREL) we could meet the complete RFS of 36 Billion Gal/yr required for 2022 with the entire corn crop in 2007 with 36.61 Billion gallons of corn ethanol. Converting at a rate of .6129 (ethanol=76,000 Btu, gasoline=124,000 Btu) we would displace 15.82% of our gasoline demand (141.85 Billion gallons/yr. 2006 EIA).

Today at 7.229 Billion Gal/yr of ethanol capacity we need 2.677 Billion bushels of corn or 20.5% of the harvest for ethanol. Using the conversion rate above this would displace 3.1% of our gasoline demand.

That gives us 423.1 gallons per acre at a 2.8 gal per bushel conversion rate. Today we would need 17.09 million acres of corn planted to meet the production capacity on line now or 3.9% of our acreage. In 2015 we will require 35.45 million acres or 8.17% of our acreage for the ethanol portion of the corn harvest. 92.9 million acres were planted for the total corn harvest in 2007 according to USDA. That is 21.4% of our farmland. For comparison, in 1914 Madison Farms in Echo Oregon used 60% of the farms production to provide fuel to feed the horsepower, so we have come a long way.

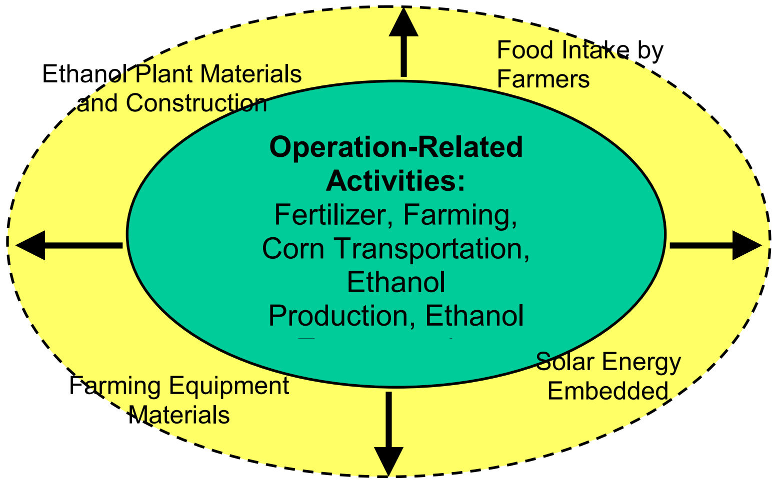
Looking into the future these numbers should get better as we get more efficient at processing (refinery creep) and yield increases, not huge increases but increases nonetheless.

Other benefits such as GHG reductions and economics are equally tough to get at because of the variables and incomplete life-cycle analysis.

Energy Returned On Energy Invested For Ethanol

A recent 2006 report entitled **"Biofuels for Transportation"** provides a list of the EROEI of five different ethanol fuel types.

Ethanol Type	**EROEI**
Cellulosic Ethanol	Range from 2-36 to 1
Ethanol Sugar Cane	8 to 1
Ethanol Wheat	2 to 1
Ethanol Sugar Beets	2 to 1
Ethanol (Corn)	1.5 to 1

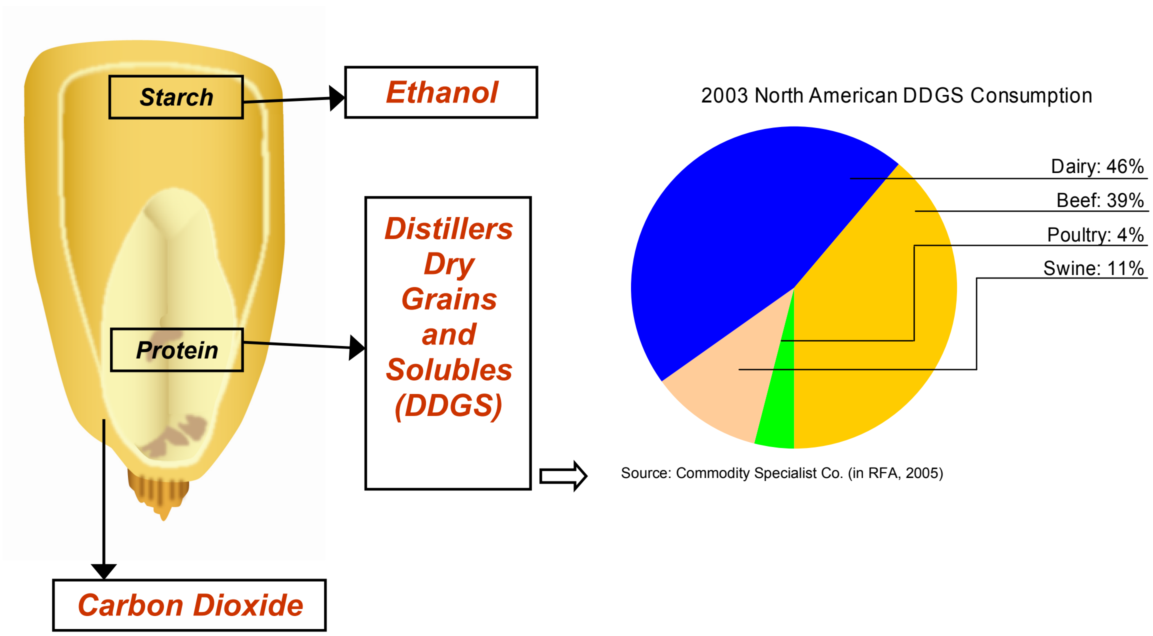


In 1995 the USDA released a report stating that the net energy balance of corn ethanol in the United States was an average of 1.24. It was previously considered to have a negative net energy balance. However, due to increases in corn crop yield and more efficient farming practices corn ethanol had gained energy efficiency. Petroleum refined to gasoline is widely accepted as having a .7 NEV. However, that is an average, an older number with little documentation of the full life cycle energy inputs.   Since marginal new petroleum should be the source of gasoline to be displaced by ethanol, thee older accepted value doesn't account for the current and new tar sands petroleum development which is both much more water and energy intensive than conventional crude production and refinement..

Opponents of corn ethanol production in the U.S. often quote the 2005 paper of David Pimentel, a retired Entomologist, and Tadeusz Patzek, a Geological Engineer from Berkeley. Both have been exceptionally critical of ethanol and other biofuels. Their studies contend that ethanol, and biofuels in general, are "energy negative", meaning they take more energy to produce than is contained in the final product.

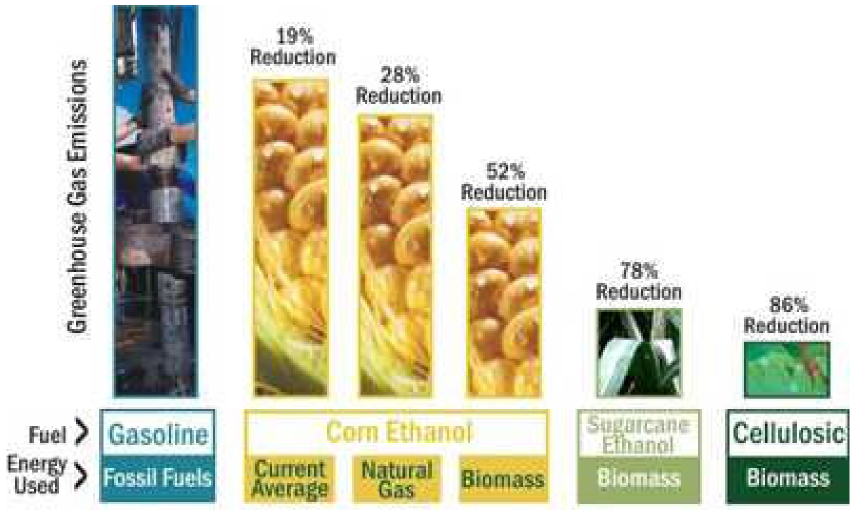
It is also important to note that ethanol is not the only product created during production, and the energy content of the by-products must also be considered. Corn is typically 66% starch and the remaining 33% is not fermented. This unfermented component is called distillers grain, which is high in fats and proteins, and makes good animal feed.

Back in 2000, Dr. Michael Wang, of Argonne National Laboratory, wrote that these ethanol by-products are the most contentious issue in evaluating the energy balance of ethanol. He wrote that Pimentel assumes that corn ethanol entirely replaces gasoline and so the quantity of by-products is too large for the market to absorb, and they become waste. At lower quantities of production, Wang finds it appropriate to credit corn ethanol based on the input energy requirement of the feed product or good that the ethanol by-product displaces. In 2004, a USDA report found that co-products accounting made the difference between energy ratios of 1.06 and 1.67. In 2006, MIT researcher Tiffany Groode came to similar conclusions about the co-product issue.



Greenhouse Gas Emissions Are Generally Lower and Getting Even Lower

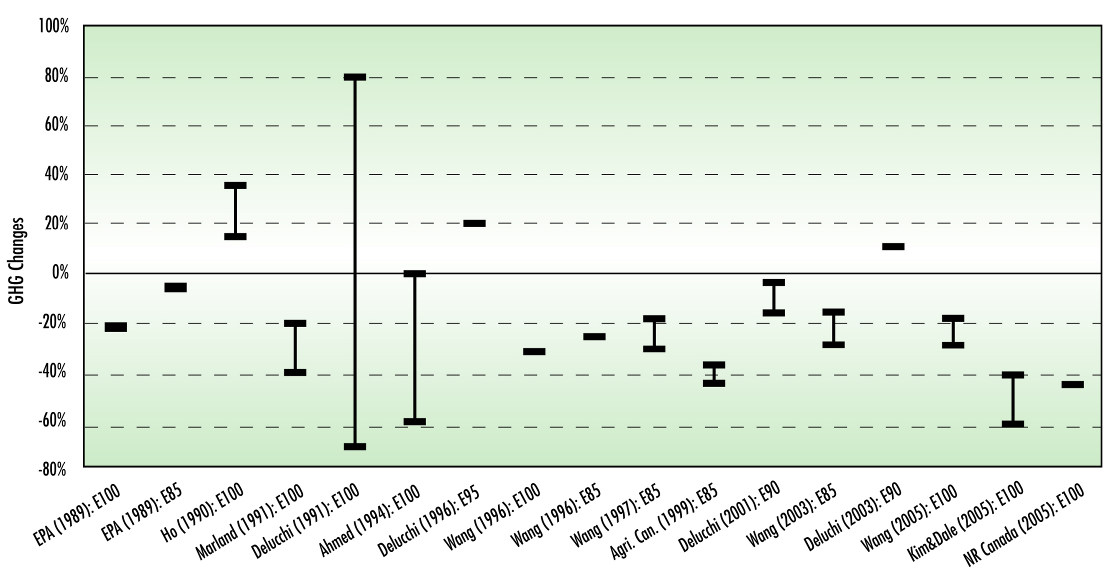
A 2006 article in Science offers the consensus opinion that current corn ethanol technologies had similar greenhouse gas emissions to gasoline, but was much less petroleum-intensive than gasoline. Furthermore, it should be pointed out that fossil fuels also require significant energy inputs which have seldom been accounted for in the past. Also, the analysis did not account for savings from use of distillers grains as animal feed, displacing other grain production, or the corn oil used.



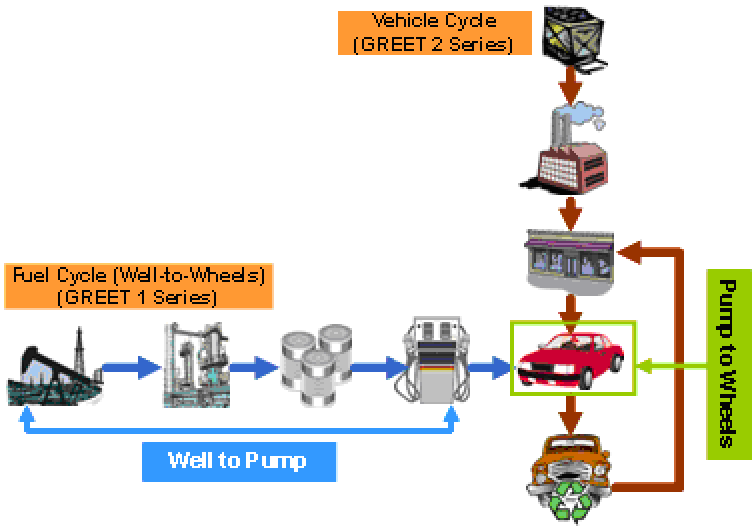
Source: Wang et al, *Environmental Research Letters*, Vol. 2, 024001, May 22, 2007

Bounds of the analysis of emissions must be set and clarified with standards for determining emissions contributions by components. Corn farming requires a significant number of chemical inputs, such as nitrogen fertilizer, phosphate fertilizer, potash fertilizer, and lime (for soil conditioning to maintain proper soil acidity). In addition, fossil energy is used to operate farming machinery, to pump water for irrigation, and to dry corn kernels.

Recent peer review studies on GHG emissions show varied GHG emission reduction by corn EtOH compared to gasoline.



To fully evaluate energy and emission impacts of advanced vehicle technologies and new transportation fuels, the fuel cycle from wells to wheels and the vehicle cycle through material recovery and vehicle disposal need to be considered. Sponsored by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE), Argonne has developed a full life-cycle model called GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation). It allows researchers and analysts to evaluate various vehicle and fuel combinations on a full fuel-cycle/vehicle-cycle basis.



GREET was developed as a multidimensional spreadsheet model in Microsoft Excel. This public domain model is available free of charge for anyone to use. The first version of GREET was released in 1996. Since then, Argonne has continued to update and expand the model. The most recent GREET versions are GREET 1.8b version for fuel-cycle analysis and GREET 2.8a version for vehicle-cycle analysis.

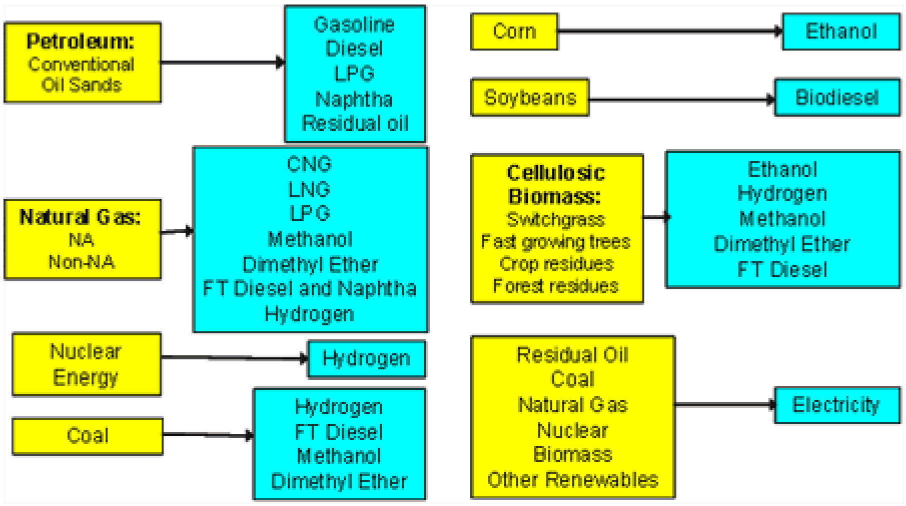
For a given vehicle and fuel system, GREET separately calculates the following:

- Consumption of total energy (energy in non-renewable and renewable sources), fossil fuels (petroleum, natural gas, and coal together), petroleum, coal and natural gas.
- Emissions of CO2-equivalent greenhouse gases - primarily carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O).
- Emissions of six criteria pollutants: volatile organic compounds (VOCs), carbon monoxide (CO), nitrogen oxide (NOx), particulate matter with size smaller than 10 micron (PM10), particulate matter with size smaller than 2.5 micron (PM2.5),and sulfur oxides (SOx).

GREET includes more than 100 fuel production pathways and more than 70 vehicle/fuel systems. These vehicle/fuel systems cover all major vehicle technologies in the market and R&D arena:

- Conventional spark-ignition engines

- Direct-injection, spark-ignition engines
- Direct injection, compression-ignition engines
- Grid-independent hybrid electric vehicles
- Grid-connected (or plug-in) hybrid electric vehicles
- Battery-powered electric vehicles
- Fuel-cell vehicles



To address technology improvements over time, GREET simulates vehicle/fuel systems over the period from 1990 to 2020, in five-year intervals.

The GREET model Net Energy Value (NEV) estimate is some 16,193 Btu/gal was derived using the replacement method for valuing co-products, and it does not include energy credits for ethanol plants that sell carbon dioxide. Corn ethanol is efficient, as indicated by an energy ratio of 1.24, that is, for every Btu of fossil fuel energy (gas, coal, dedicated to producing ethanol, there is a 24-percent energy gain.

Is Ethanol Becoming More Efficient?

A 2006 Argonne National Laboratories analysis shows improvement in ethanol production efficiency. In 2006, U.S. ethanol production was 4.9 billion gallons, an increase of 276% over 2001 production. The study shows, that in the past five years, on a per gallon basis by weighted average of dry and wet ethanol distilleries, that:

- Water consumption is down 26.6%
- Grid electricity use is down 15.7%
- Total energy use is down 21.8%

Higher Food Prices Primarily Driven by High Oil Prices

The Agricultural and Food Policy Center at Texas A&M University recently published a study showing that corn prices have had little to do with rising food costs.

They concluded that the underlying force driving changes in the agricultural industry, along with the economy as a whole, is overall higher energy costs, evidenced by $100 per barrel oil.

They found that important food items like bread, eggs, and milk have high prices that are largely unrelated to ethanol or corn prices, but correspond to fundamental supply and demand relationships in the world.

The study also noted that relaxing the Renewable Fuels Standard would not result in significantly lower corn prices.

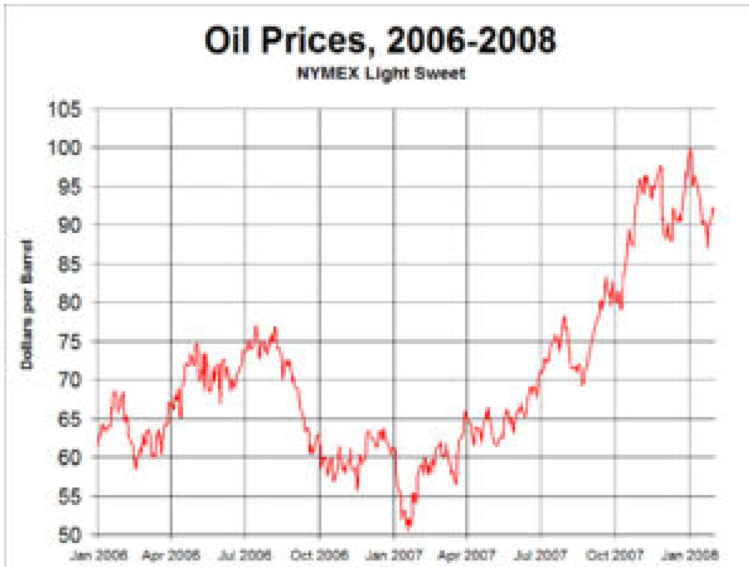
To view the study in its entirety, please click here: The Effects of Ethanol on Texas Food and Feed. http://www.afpc.tamu.edu/pubs/2/515/RR-08-01.pdf

CARE and Oxfam stated on April 18, 2008 that the world wide food crisis calls for eight things:

- Increase donor and national government investment in small-scale agriculture in developing countries.
- Ensure financial services such as insurance and credit are available to poor farmers.
- Allow space for national trade policies to manage food security and rural development and to support the poorest and most marginalized farmers.
- Recognize that climate change is going to exacerbate these problems, requiring urgent mitigation and adaptation response.
- Eliminate trade-distorting export agricultural subsidies, export restrictions and price controls.

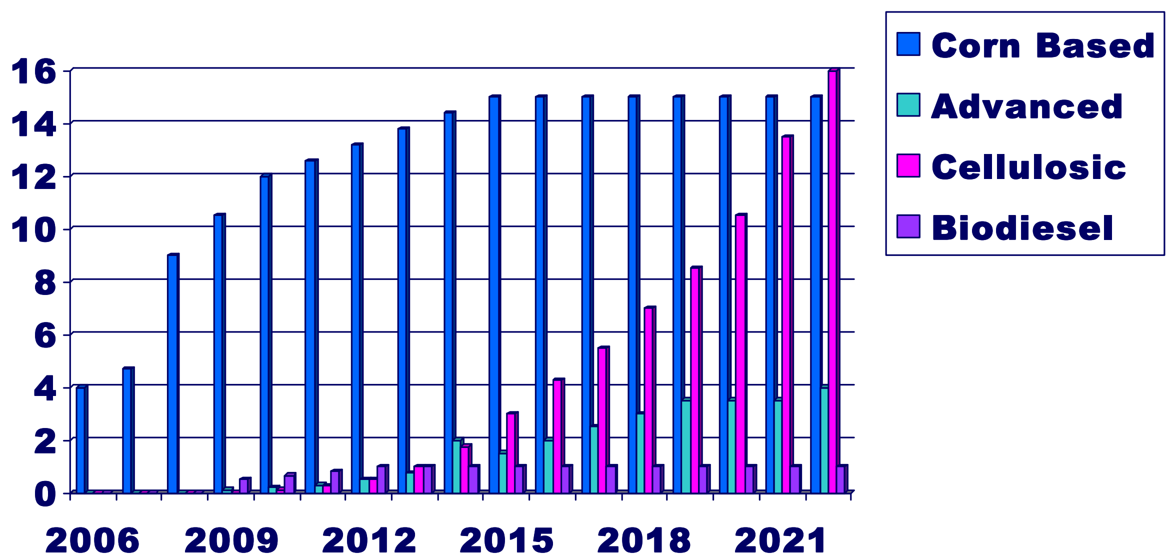
And, the eighth item is that large-scale growth in biofuels demand has pushed up food prices and so far there is little evidence that it is reducing overall carbon emissions. Natural carbon sinks such as rainforests and grasslands are being destroyed to make way for new biofuel plantations and biofuel crops are displacing food production. Countries driving biofuel demand need to monitor the impacts of their policies on global food security and provide financial support for affected countries. Mandatory targets need to be reassessed in terms of likely impact on emissions and negative social and environmental side effects in developing countries, including higher food prices, land grabs and labour rights abuses. Developing countries need to integrate their biofuel strategies with food security policies to address issues such as land allocation and crop use.

No reference was made in the Oxfam report regarding the doubling or 100% increase in petroleum the past twelve months.



Energy Independence and Security Act, 2007 (EISA)

Under the targets set in the Energy Independence and Security Act of 2006 (EISA) the U.S. market will require 15 Billion Gal/yr of corn ethanol in 2015. We will need 5.56 Billion Bushels of corn or 42.5% of this years harvest amount. Using the conversion above, this will displace 6.5% of our gasoline demand.



- 36 billion gal/yr by 2022
- Corn ethanol capped at 15 billion gal/yr
- Advanced biofuels at 21 billion gal/yr

- Of that 21 billion gal/yr 16 billion gal/yr must be cellulosic ethanol and 1 billion gal/yr biodiesel
- Corn ethanol must have a 20% reduction in lifecycle GHG emissions
- Advanced biofuels must have a 50% reduced lifecycle GHG emissions
- Cellulosic ethanol must a achieve a 60% reduction in GHG

Cellulose is tougher to calculate because much of it will come from agricultural waste and marginal land. It does have a similar range of yield, 350 to 450 gallons per acre. Many assumptions would have to be made to calculate the impact of the 16 Billion gallons of cellulosic ethanol mandated by EISA in 2022.

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