Rethinking the Value of Corn Ethanol Co-Products in Lifecycle Assessments

An Ethanol Across America White Paper — Summer 2009

Producing More Food and Fuel with Less Carbon

In the long and successful history of first-generation ethanol (i.e. ethanol from starch) — and despite the significant energy, economic and environmental benefits it has provided — the critics remain.

Even in the best of times, as ethanol proved to be a catalyst for a renaissance in rural America, there were whispers: *"They are using food to make fuel."* Even as the new ethanol market demand resulted in a new generation of farmers and technology, the misinformed questioned how the U.S. could fashion energy policy out of what they perceived to be food products. *"We will run out of food"*, they said. *"We should be feeding people, not our gas tanks."* Stoked by a very successful misinformation campaign against ethanol, some came to the conclusion that more ethanol meant less food — and more expensive food.

Now these misinformed critics are faced with a puzzle: The fact is that corn production has not only met the increased demand for ethanol, but has also led to our farmers meeting (and often exceeding) every other demand sector. How can that be possible?

The critics leap to the conclusion that farmers must be using more land — pristine, conservation land — even our national forests! And if this is indeed the case, farmers must not only be reducing our food supply but generating carbon emissions in the process. The chorus of critics and detractors — people apparently opposed to the greater choice and control that a competitive biofuels market offers — grew louder and falsely faulted the ethanol industry for increasing CO_2, generating greenhouse gases (GHG) and contributing to climate change.

On top of this, the "food and fuel" debate reached near hysteria toward the end of 2007, throughout 2008 and well into 2009. Ethanol was targeted as the culprit for rising food prices, with little attention paid to the facts (such as the significant impact of petroleum-based energy costs at every stage of food production and distribution) — or to what is really happening in American agriculture today.

As commodity prices have returned closer to norms prior to the dramatic speculation-driven increase, we need to take a deep breath and understand the truth. We are meeting the increase in demand for fuel, while feeding

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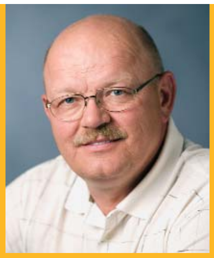
Dave Vander Griend



Dave Vander Griend is president and CEO of ICM, Inc., a Colwich, KS company that designs, builds and supports ethanol plants — with a particular emphasis on improved process design and energy efficiency.

Raised on a farm near Sheldon, IA, Dave was vice president of operations for High Plains Corporation (now Abengoa Bioenergy) before founding ICM in 1995. The company has grown from 20 employees to more than 300, offering a wide range of engineering and technical services for ethanol producers. ICM is driven to help sustain agriculture by more efficiently and profitably transforming grain into fuel, feed and food.

Dave received the Distinguished Service Award at the 2003 BBI International Fuel Ethanol Workshop (FEW) in recognition of his more than three decades of innovation and leadership.

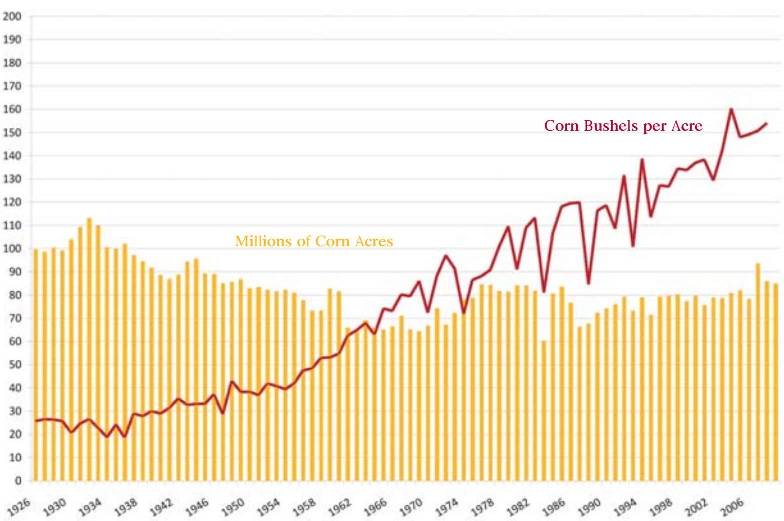


Fig. 1 More corn on less land. *USDA data clearly shows U.S. corn acreage has declined over the past 80 years, yet corn production has increased due to improved management practices and seed technology.*

more people through exports — and unleashing technology in every aspect of corn production. American farmers are using less land to produce more corn — continuing a 50-year trend of more bushels per acre *(Fig.1)*. And there is every reason to believe this trend will continue.

A **realistic** look **at the net impact of corn** usage **for ethanol.**

As productivity on the farm and in the ethanol plants increases, it is critical to understand the **net impact** of corn ethanol on the corn supply. Many believe that so-called “energy crops” such as switchgrass would be infinitely better for the environment than corn-based ethanol. Others contend that sugarcane is the “magic” feedstock given its high yield and low energy inputs.

But for these non-food feedstocks, the story is one-dimensional. They produce no food ingredients or animal feed, so their value stops abruptly at ethanol production — and as such, their net value is considerably less than corn-based ethanol. *(Fig. 2)*

ENERGY CROPS	SUGAR	CELLULOSE	STARCH
	Sugarcane	Switchgrass	Corn
TONS/ACRE	35	10	8.2
YIELD (GALLONS)	560	850	431
FEED CREDIT	0	0	<50%>
NET VALUE	**560**	**850**	**862**

TONS: Based on the national average
YIELD: This signifies the Current Technology being deployed, 154 x 2.80 = 431 gallons
FEED CREDIT: SWITCHGRASS & SUGARCANE - Have no food value for the byproduct: (2) bushels corn residual (DDG) = 1 bushel of corn
NET VALUE: (2) acres of corn to ethanol = (1) acre of feed grain displacement

Fig. 2 **Corn ethanol gets feed credit. Others don't.** *When we make ethanol from corn, we also make livestock feed. Sugarcane and switchgrass only make ethanol. Corn ethanol has a higher net value than other ethanol fuel sources.*

While “energy crops” hold great promise, they have not been grown or harvested in commercial quantities. There are numerous issues that may arise relative to relying on them for energy utilization including storage, transportation, ethanol yield and overall logistics and marketing challenges yet to be addressed.

When we make fuel, we also make feed.

Recognition of the co-products that come from ethanol production is absolutely fundamental to understanding the true value of corn as a food and energy crop. For the majority of ethanol plants in the U.S., the key co-product of ethanol production is dried distillers grains (DDG) — the high protein feed product that remains after low-value starch is removed to make fuel. DDG returns a substantial *one-third by volume* to the feed supply.

And that's not all: Due to the high feed value of DDG, the nutritional value is 50% that of raw corn, even though the volume is just one-third. When we harvest an acre of corn for ethanol production, we're actually only using half of the equivalent of that acre to make ethanol. The other half is returned in nutritional value to feed livestock for the human food supply.

Dr. Terry Klopfenstein, a well respected animal nutrition expert at the University of Nebraska, has concluded that the energy value of DDG when fed to cattle is as much as 145% of the original corn *(Fig. 4)*. He contends this feed credit needs to be calculated when determining the overall demand for corn for ethanol production. Essentially, every two bushels of corn that enters an ethanol plant returns the equivalent of one bushel to the feed chain. This is an extraordinary factor that must be considered when calculating the land use impact of corn ethanol — and, by extension, the carbon emissions associated with corn ethanol production.

In effect, ethanol production extracts the fuel from the corn before returning the feed to the food production chain. And that feed has considerably higher value than the raw corn that entered the biorefinery.

We're not going to run out of corn.

Figure 3 illustrates the historical use of U.S.-produced corn from 2000, with projected use to 2015. Corn to industrial use for food and animal feed (meat production) will likely remain flat or decrease in coming years, due primarily to changing diets in the U.S., where meat consumption is falling. Corn exports are expected to remain relatively flat at 2 billion bushels annually.

Corn used for ethanol will flatten at about 5.3 billion bushels per year as corn ethanol is essentially capped by the Renewable Fuels Standard. As noted in this paper, the DDGs produced by ethanol plants will likely replace nearly one-half of the raw corn diverted from the feed market and used for ethanol. Combined with a higher feed conversion and lower price than raw corn, DDG is likely to displace raw corn in feed to the largest extent possible, pushing approximately ***2.6 billion bushels of corn equivalent back into circulation!***

Those 2.6 billion bushels will join the already enormous projected carryouts of between 2 and 3 billion bushels, resulting in total annual carryout (surplus) of the U.S. corn supply of 5 billion bushels per year in 2015. This relentless growth in corn production (and thus supply) is driven mainly by the ever-growing average corn yield, as U.S. farmers continue to grow more corn on less land. While corn acreage has fallen over the past eight decades, yield per acre has more than tripled, and yield growth is accelerating.

It's a common (and wrong) assumption that this increase in productivity is the result of excess fertilization. Not so. Yield increases are the result of a number of efficiency measures — from conservation tillage to precision agriculture technology that allows farmers to reduce inputs, environmental impact

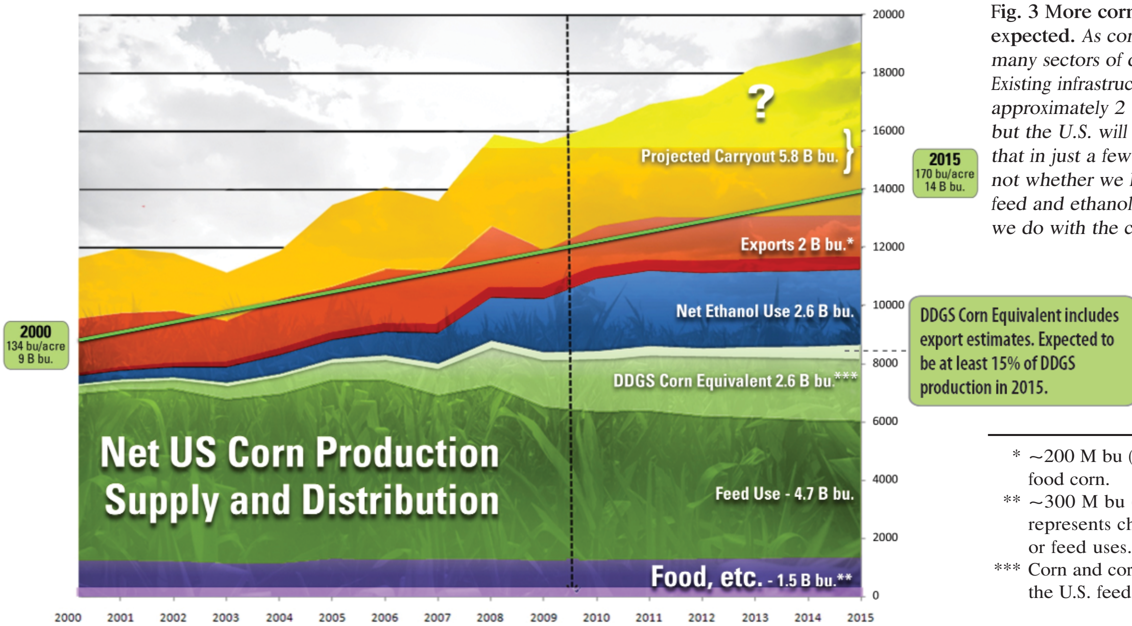


Fig. 3 **More corn than you might have expected.** *As corn yields per acre increase, many sectors of demand are flattening. Existing infrastructure can support storage of approximately 2 billion bushels as carryover, but the U.S. will see much more corn than that in just a few short years. The question is not whether we have enough corn for food, feed and ethanol. The question is: What do we do with the corn that's left over?*

* ~200 M bu (10%) of "Exports" represents food corn.
** ~300 M bu (20%) of "Food, etc." represents chemicals and other non-food or feed uses.
*** Corn and corn equivalent better illustrates the U.S. feed demand for meat products.

and carbon emissions. Additionally, advancements in hybrid seed development have improved resistance to drought, pests and other stressors — dramatically reducing the need for water, chemicals and trips across the field.

Since we are unquestionably meeting increased corn demand from the same amount of land (or less) — and producing more food ingredients in the process (animal feed, sweeteners, etc.) — and exporting those value-added products — then corn-based ethanol has no significant impact on land use. Moreover, as productivity increases in both cornfields and within ethanol plants, corn ethanol may lay claim to ***reducing land use*** — another trend documented by USDA, National Agricultural Statistics Service (NASS).

Let's level the playing field in the land use game.

This segue into land use demands that we address the issue of indirect land use change (ILUC). Basically, the ILUC argument attempts to extrapolate global changes in land use and the subsequent carbon emissions that may occur when the U.S produces biofuels. In essence, ILUC poses the bizarre question: *"If an acre of American corn is used to produce biofuels, what impact does that have on the conversion of pristine lands to agricultural use in South America or Africa? And what effect does that conversion have on greenhouse gas emissions?"*

Suffice it to say that the science behind ILUC is less than solid — and that making decisions that will have a profound impact on our nation's economic and energy security based in part on shaky assumptions is clearly not in our nation's best interests, or that of the American consumer.

ILUC is little more than an unproven theory. Here are the facts: In January 2009, a study published by Yale University's *Journal of Industrial Ecology* concluded that corn ethanol directly emits an average of 51% less greenhouse gas than gasoline.

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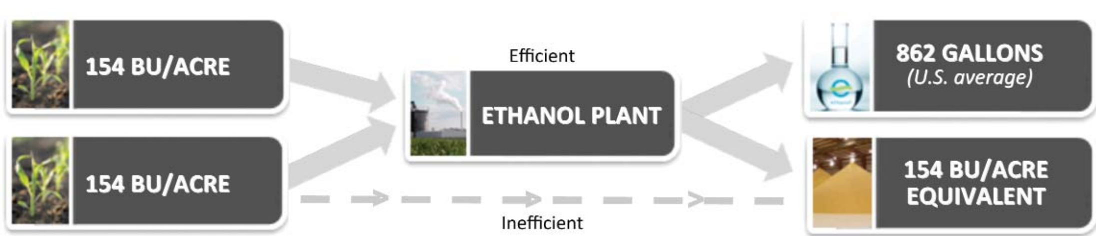

Fig. 4 **Returning one bushel of corn for every two used.** *Nearly all corn consumed by ethanol plants comes from the feed corn supply, but since corn ethanol returns livestock feed to the market, the net corn disappearance due to ethanol is only one-half the gross corn consumption of the plant. According to Dr. Terry Klopfenstein of the University of Nebraska, on a dry weight basis, 33% of the corn is left for utilization as livestock feed in the form of distillers grain. But since DDG has 145% the feed value of raw corn, the net effect is that for every two bushels of corn used to make ethanol, one bushel of feed equivalent is returned.*

That's *more than three times* the reduction reported in earlier research. The key difference is recent efficiency improvements in the ethanol production process.

Various studies have found ethanol to have an exceptionally positive carbon footprint relative to fossil fuels; but due to the arbitrary and unproven ILUC argument, biofuels are being singled out to meet different and more stringent standards than fossil fuels. Subsequently, ILUC has become part of the low carbon fuel standard (LCFS) equation by which the carbon value of fuels is determined. But this assessment is only applied to biofuels — not fossil fuels. If we're going to use ILUC as a criterion in evaluating the value of fuels, let's at least apply it to all fuel sources.

The real numbers behind net corn usage.

Perhaps the issue of **net corn usage** was best stated by five distinguished land grant university professors with extensive agronomic and agricultural expertise. In an April 2009 letter to key Obama Administration officials, these experts outlined three major points:

With a current industry average of 2.8 gallons of ethanol per bushel of feed corn processed — and with the near 50% return value of DDG — the net corn use is half of the 5.4 billion bushels reported by USDA, since 2.6 billion bushels are returned to the feed supply. Secondly, the net amount of corn needed to meet the RFS of 15 billion gallons of corn ethanol is just under 3 billion bushels. With significant increases in yield, there will not only be enough corn to meet every other demand sector including exports, but there will be looming surpluses. Thirdly, and the key to the current debate: The increased feed value and increased yields mean the RFS requires *no new acres to produce ethanol* — and consequently there are *no land use changes and no increase in carbon emissions.*

The U.S. is simply proving it can make more fuel from its energy crop (feed corn) on less land with fewer inputs — all while increasing the supply of feed products. Clearly, U.S. farmers and the U.S. ethanol industry are already achieving the national goal of creating more fuel, feed and food — with less carbon.

It is becoming increasingly clear that the production of advanced biofuels may take longer than Congress has prescribed, certainly in the aggressive quantities called for. Given the considerations of the true net value of corn ethanol, there is no reason to cap corn production. Doing so would curtail the undeniable trend of productivity and yield that is within our reach.

I would ask each American: **What is most important to you**?

- **Is it energy independence**? Domestic ethanol production reduces imported oil requirements.
- **Is it our sons and daughters in the military protecting supply lines of imported oil**? Domestic ethanol creates U.S. jobs producing and distributing domestic products.
- **Is it our economy**? Domestic production keeps our dollars at home, recirculating and growing our economy.
- **Is it clean air**? Ethanol reduces tailpipe emissions and has reduced smog in our major U.S. cities.
- **Is it food**? The U.S. is the most productive country in the world, and we are exceeding world demand for grains.
- **Is it global warming**? As controversial as this issue is, ethanol from starch has a net carbon comparable to all energy crops.

In the ethanol industry, we have always felt that corn ethanol is a bridge to advanced technologies such as cellulose or other feedstocks. That bridge is not only solid, but we should look at options to extend and strengthen it — not burn it.

ICM the energy of innovation

Resources for this Ethanol Across America White Paper were provided in part by ICM, Inc.

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Ethanol Across America

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