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As Biofuels Enter The Food Chain What Is Next For Agriculture?

Across-the-table effect will likely be felt on both fertilizer product use and on the knowledge-based services associated with using those products effectively.

Agriculture as a source of fuel is far from a new concept. However, the advent of new technology, coupled with a desire to reduce dependence on imported oil, has us in the midst of a modern-day agricultural revolution. Use of corn for ethanol production has been skyrocketing with a 20 percent increase in the '05 season and a projected increase of another 30 percent in the '06-'07 season, exceeding 15 percent of the entire U.S. corn crop. This puts even greater pressure on world coarse grain stocks, estimated at 12 percent of total use for the '05-'06 crop year, a 30-year low, and part of a 10-year trend of steady declines in spite of several phenomenal global crop years.

Increased corn demand has led to substantial increases in corn prices. Corn prices over the last eight years have averaged \$2.05/bu while predicted average CBOT

SUMMARY

Summary: The development and expansion of the biofuels industry may well mark the end of an era in agriculture, an era that began in the 1980s with LISA (Low Input Sustainable Agriculture) and the publication of "Alternative Agriculture" by the National Research Council (1989). It was an era dominated by the mindset that production was the problem and input reduction was the solution. Perhaps biofuels and the array of co-product opportunities that are appearing along with it offer a new mindset where sustainable development of the real potential of modern agriculture to harness the sun's energy in meeting food, feed, fiber, and fuel needs becomes the focus. Such a mindset is ripe with opportunity for the fertilizer industry provided the steps taken are not only good business moves but also are grounded in science-based sustainable practices leading to efficient and effective nutrient management and resource use.

prices for the next three years are in the range of $3.17 to $3.63/bu. Such a price jump across the 11 billion bushel U.S. corn crop translates into an additional $11 billion in gross revenue to corn producers.

The impact of higher corn prices will be far-reaching and likely include: more corn acres and fewer acres of other crops; changes in government farm programs; a shift in attitudes and management emphasis; livestock industry shifts in feeding, revenues, and perhaps geography; transportation challenges; and input industry implications, including those for the fertilizer industry.

Yield increase

Increased demand for corn can be met either by increasing acres or increasing production per acre. Higher prices provide incentives for both.

Figure 1 shows what a 3 percent annual rate of increase looks like projected out to 2020 and contains a table translating the yield increases into additional production. The N, P, and K contained in the additional annual production in 2020 amounts to 18, 21, and 13 percent, respectively, of the entire current U.S. fertilizer use (average of 2004-2006). If the genetics industry can deliver on the promised increased genetic potential, and if agronomic researchers, educators, crop advisers, and growers can convert that genetic potential into bushels in the bin, we will indeed be in the midst of a revolution not experienced since the hybridization of corn.

It will be critical for sustainability of the resulting modified system that the changes contribute positively to environmental impacts, namely that nitrate and phosphate losses to surface and ground water are reduced; soil erosion and soil loss from the field are lessened; nitrous oxide and ammonia emissions to the atmosphere are reduced; carbon is sequestered in the soil or at least maintained; and water is used appropriately.

Corn acreage increase

A substantial increase in corn acreage has occurred in 2007 and about a 15 percent increase over the 2004 to 2006 acreage is being estimated by the USDA. Much of the increase has occurred in the traditional corn-soybean rotation regions of the Corn Belt, resulting in an increase in corn on corn acres.

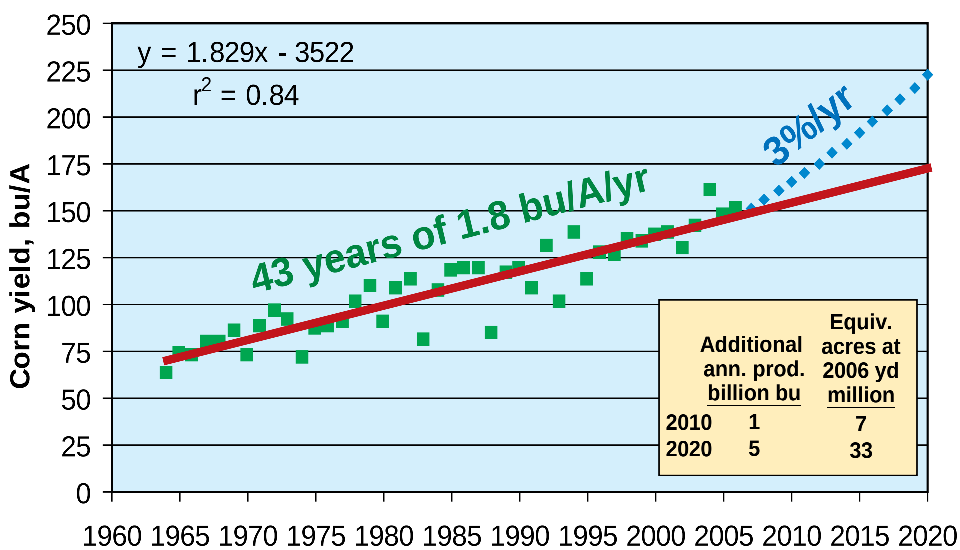


Figure 1. Genetic improvement in corn yields promised by the biotech industry.

Table 1. Impact of adding 10 million acres of corn from soybean acreage in the U.S.

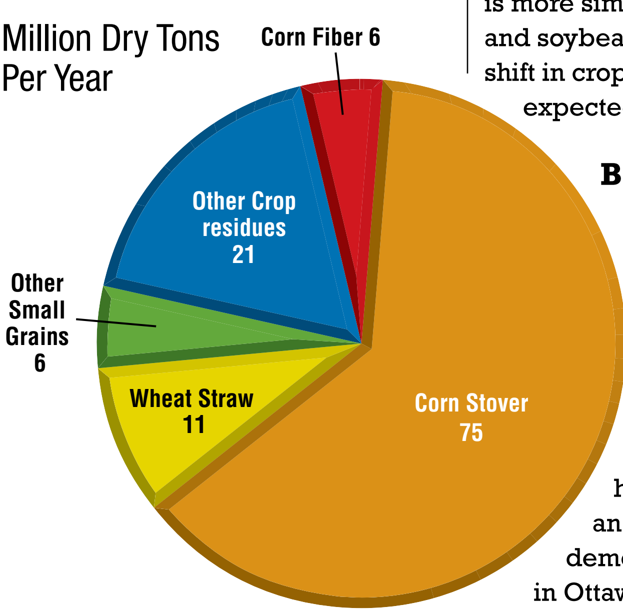
	Fertilizer use (1,000 tons)		
Change	N	P_2O_5	K_2O
+ 10 million acres of corn	660	234	270
- 10 million acres of soybeans	-26	-76	-136
Net	**+634**	**+158**	**+134**

Based on USDA Ag Chemical Use Survey, average of 2003 and 2005 for corn and 2002 and 2004 for soybeans.

A likely scenario is depicted in Table 1 where per acre use in the new corn area is assumed to be the same as that reported by the USDA Survey. In other words, the new corn acres are fertilized as in the past. It is also assumed that the 10 million acres are drawn from soybean ground so that the fertilizer that would have been applied on soybeans is subtracted from the new total applied on the corn.

However, continuous corn does not receive a soybean credit so N use will likely increase on those acres by perhaps 30 lbs/A. Since there will be 10 million fewer acres of soybeans to rotate with corn in the second year, an increase of 10 million acres of corn this year results in 20 million acres of corn on corn the following year. With these adjustments made, a 10 million acre increase in corn would result in U.S. increases of 7.6, 3.5, and 2.6 percent in N, P, and K use, respectively.

An additional 3 million acres of corn appears to have been taken out of cotton acres in 2007. Since fertilizer use on corn and cotton is more similar than between corn and soybeans, the impact of this shift in cropping on fertilizer use is expected to be considerably less.



Perlack et al., 2005

Figure 2. Current sustainable availability of cellulosic biomass from agricultural lands.

Biomass

The production of ethanol from cellulosic biomass occurs today only on a pilot basis but progress is being made toward commercialization.

Iogen Corporation has been operating an 800,000 gallon/year demonstration scale facility in Ottawa, Canada, producing ethanol from wheat straw. This facility represents the final proving stage prior to full-scale commercial bio-refineries, each designed to process annually more than 1.5 million dry tons of crop residues into 100 million gallons of ethanol. In 2007, Iogen also plans to initiate construction of a 20-million gallon commercial plant in Idaho's Snake River Valley to make ethanol from wheat straw, with operation anticipated by 2009.

Abengoa Energy, and DuPont and Broin have announced plans to get into cellulosic ethanol production.

If cellulosic ethanol production does become a commercial reality as many experts are predicting, the impact on the fertilizer industry and nutrient cycling could be large, especially for K. Corn stover is expected to be a major initial feedstock due in part to a plentiful supply, with current sustainable availability estimated at 75 million tons per year (Figure 2). Nutrient content of stover entering a bio-refinery could be extremely variable due to variation in plant nutrient uptake, foliar leaching during crop senescence, extent of weathering in the field, or harvest techniques. Using average figures, 75 million tons of harvestable corn stover would contain nutrients equivalent to 6, 5, and 23 percent of annual fertilizer sales of N, P, and K, respectively.

Thinking in terms of bio-refinery capacity helps visualize how a commercial cellulosic industry might get started. Though bio-energy literature indicates considerable uncertainty in commercial scale details, an 80-million gallon refinery seems to be in the central range of the capacities presented as does an estimate of 80 gallons of ethanol per dry ton of stover. Therefore, a reasonable estimate of the stover demand for a refinery is a million tons of stover

Table 2. Reference points for the potential impact of biofuels on fertilizer use in the U.S.

	1,000 tons			% of annual U.S. fertilizer ('04-'06)		
Ethanol source	**N**	**P_2O_5**	**K_2O**	**N**	**P_2O_5**	**K_2O**
Grain (10 mil ac from soy)[1]	934	158	134	7.6	3.5	2.6
Grain (3 mil ac from cotton)[1]	95	30	14	0.8	0.7	0.3
10 refin. Stover–10 mil tons[2]	80	29	200	0.6	0.6	3.9
BE (10 mil ac, 6 t/ac)[3]	550	134	690	4.5	2.9	13.5
Total	**1,659**	**351**	**1,038**	**13.5**	**7.7**	**20.3**

[1]Net increase in fertilizer use. [2]Nutrient removal; represents 16 percent of sustainable, collectable stover based on 1995-2000 production with no change in tillage (Graham, et al., 2007) [3]BE = bioenergy crops such as switchgrass; 50% of removal for P and K; 110 lbs/A of N.

and 10 refineries would require 10 million tons per year or 6 to 7 million acres supplying corn stover.

Switchgrass

Once cellulosic ethanol production is commercialized, energy crops such as switchgrass are bound to enter the scene in short order. These are often described as "low input" species not requiring fertilization, or at most, minimal fertilization. However, studies have shown these species are highly responsive to N fertilization and can remove large quantities of nutrients, especially K, though content is extremely variable. For example, at the assumed K_2O content of 46 lbs/ton, 10 million acres of 6-ton/A switchgrass would remove a quantity of K equivalent to 27 percent of total U.S. K fertilizer consumption.

The question remains of what large nutrient removal by biomass crops and crop residue harvest means to the fertilizer industry. At first glance it appears to represent a potentially large increase in fertilizer demand. Yet when one considers the fate of the nutrients being removed, the vision of these removed nutrients as raw material for a new fertilizer source or sources appears.

Potential impact

Potential impact of biofuels on fertilizer use is offered in Table 2. This table does not include the impact higher crop prices and accelerated development of crop genetic potential might have on nutrient management across all planted acres. The across-the-table impact will likely be felt on both fertilizer product use and on the knowledge-based services associated with using those products effectively. What this article has attempted to do is connect reference points of biofuel growth to fertilizer use impact and potential opportunities.

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