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Can Agriculture and Evironmentalists Align Interests?

Yes, says author. How? By ensuring global food security, protecting biodiversity, improving water quality, and reducing reliance on imported oil.

Summary: *While I firmly believe that commodity agriculture in the Corn Belt can play a critical role in ensuring global food security and at the same time protect biodiversity, improve water quality, and reduce reliance on imported oil, I also believe that the key limitation to convincing environmentalists of this capability is lack of good science and data.*

Few studies have sought to measure all of the critical parameters in well-designed production-scale field research to obtain the required data sets. Such research requires substantial investment in environmental monitoring equipment, technical support, and field operations. I suspect that if such an effort were made using progressive crop and soil management practices, it would unequivocally document the potential to improve environmental quality in production systems that would prove highly energy efficient, producing grain yields 30 percent greater than today's average yield. Given this scenario, I believe it would be possible to convince both environmentalists and the general public that federal farm programs should provide incentives that encourage renewable energy production from corn and soybeans.

It is the premise of this article that despite distrust of the environmental movement, there is an urgent need and tremendous opportunity to recruit urban support for agriculture, and in particular, active support of key environmental groups.

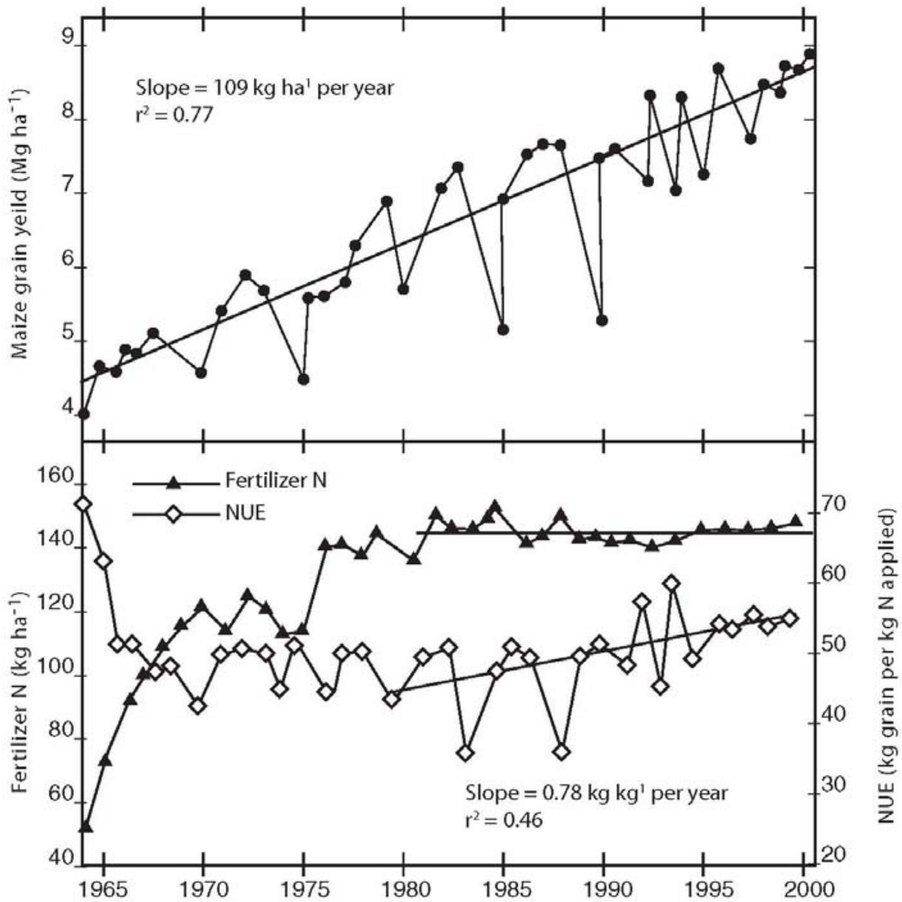

Figure 1. Trends in maize grain yield, use of N fertilizer, and NUE in the USA, Cassman et al. 2002

Convergence of interests. Of all human activities, agriculture is practiced on an area representing about 33 percent of the earth's surface and it uses a majority of the world's available freshwater supply and nitrogen (N) of anthropogenic origin. Because it appropriates so much of the world's natural resources, it is no wonder that agriculture receives close attention from environmental groups. An issue is whether farmers and agricultural industries can help address the concerns of the general public and environmental groups and gain their support for a more profi table and vibrant agricultural sector. I contend that recent research and development of new techniques have laid the foundation for such an alliance as illustrated in the following examples.

Biodiversity. The single greatest threat to biodiversity worldwide is the expansion of agriculture into natural ecosystems such as rainforests, grasslands, and wetlands—*especially*

Table 1. Corn yield and NUE obtained in three cropping systems in which progressive crop and soil management practices* were employed in quarter section fields (approximately 160 acres), 2001.

System	Yield bu/A	N Fertilizer lbs N/A	NUE bu/lb of N
Irrigated			
Corn/soybean	217	137	1.59
Continuous corn	209	175	1.20
Rain-fed			
Corn/soybean	142	114	1.25
USA Corn Avg.	135	140	1.03

* Progressive management practices include no-till, soil-test-based N fertilizer recommendations, split N applications and pivot fertigations, ETbased irrigation scheduling, Bt corn hybrid.

Table 2. Life-cycle energy balance* (in diesel fuel equivalents) in high-yield irrigated continuous corn used to produce ethanol, U of Nebraska.

System	Energy Output	Energy Input	Net Energy Gain (output/input ratio)
Irrigated	981	767	215 (1.3 to 1)
Rain-fed	686	470	166 (1.4 to 1)
USA Corn Avg.	135	140	1.03

* Energy balance includes all energy inputs used in corn production (fertilizer, irrigation, field operations, etc.), transport from the field to the ethanol plant, and ethanol production. Energy outputs include energy content of the ethanol produced and the wet distillers grain.

in developing countries. If yields and food output do not keep pace with population growth on the good arable land now in production, it will be impossible to protect the remnant natural ecosystems from being turned into farmland, and much of this expansion will occur on marginal lands not suited for continuous cropping.

Sustaining increases in crop yields will require improved crop cultivars and hybrids, as well as improved pest protection, crop nutrition, and maintenance of soil fertility. Potential supply of organic nutrients is simply not large enough to be a significant factor in raising crop yields and maintaining soil fertility. Therefore, environmentalists concerned with protecting natural ecosystems and biodiversity must eventually come to recognize the need for increasing crop yields on existing cultivated land through appropriate use of fertilizer nutrients.

Data worldwide shows that maintaining an adequate supply of food crops to meet global demand will depend on maintaining an annual rate increase in yield on existing farmland of about 1.4 percent in major producing countries. An even higher rate of growth in yield will be required if these crops are increasingly used for bio-energy and bio-based feedstocks for industry.

Thus, to protect biodiversity and natural ecosystems, it is much preferable to increase yields on existing farmland. I suspect that the environmental movement will soon come to embrace intensification of agriculture in order to avoid agricultural expansion into native grasslands, wetlands, and rain forests—especially in Argentina and Brazil.

Water quality. The greatest threats to water quality are soil erosion, leaching, and runoff of N and phosphorus (P) from agricultural systems. Both can be greatly reduced via conservation tillage methods and use of improved nutrient management practices that have been widely adopted in the U.S. in the past 25 years. For example, N fertilizer use on USA corn reached a peak in 1980 and has remained constant since then although corn yields have increased steadily by 1.7 bu/A/yr (Figure 1). Taken together, these trends have contributed to a 35 percent increase in N-use efficiency (NUE)—from about 0.76 bu/A of corn produced per pound of N applied in 1980 to 1.03 bu/A per pound applied in 2000.

Despite this progress, however, average N fertilizer uptake efficiency by corn and the other major cereals averages 30 to 50 percent of applied N, which means that 50 to 70 percent of applied N is at risk of being lost to the environment via leaching, volatilization, and denitrification.

The potential scope for improvement in NUE is best illustrated by recent studies from a productionscale field study conducted by the University of Nebraska Carbon Sequestration Program, which have demonstrated the potential to achieve a substantial increase in both crop yields and NUE (Table 1). Several aspects of crop management used in this study were derived from our Ecological Intensification program funded in part by the Fluid Fertilizer Foundation. The potential to sequester carbon in soil organic matter, which contributes to improved soil quality and a reduction in carbon dioxide emissions, is being measured in both studies. Our working hypothesis is that progressive crop and soil management practices make it possible to achieve substantial increases in yield and NUE while improving soil quality and achieving a net reduction in greenhouse gas emissions. Likewise, simulation modeling studies based on this work indicate tremendous untapped potential to increase carbon inputs to soil through return of stover in irrigated continuous corn systems that consistently achieve yield levels near the yield potential ceiling of current hybrids (Figure 2).

Renewable energy. Substitution of renewable energy for imported oil is a goal that resonates strongly with both the general public and the environmental movement. Ethanol production from corn grain, and eventually from crop biomass, is one option to produce renewable energy and decrease net emissions of greenhouse gases by burning renewable fuel rather than fossil fuels.

The big issue is whether ethanol can be produced from corn in a manner that is energy efficient and without negative effects on the environment. It turns out that NUE has a major impact on both energy and environmental aspects of ethanol from corn because N fertilizer represents about 50 percent of the total energy used in corn production systems, and losses of N have a major influence on ground and surface water quality. I would argue that the most relevant analysis of energy efficiency in corn-to-ethanol systems should be based on progressive crop and soil management technologies used by the top 5 to 10 percent of corn growers using farming methods that are likely to be widely adopted within 10 to 15 years (or more quickly with appropriate policies and investment in extension). The trajectories in both yields and NUE of the past 25 years suggest that such progress will continue into the foreseeable future (Figure 1).

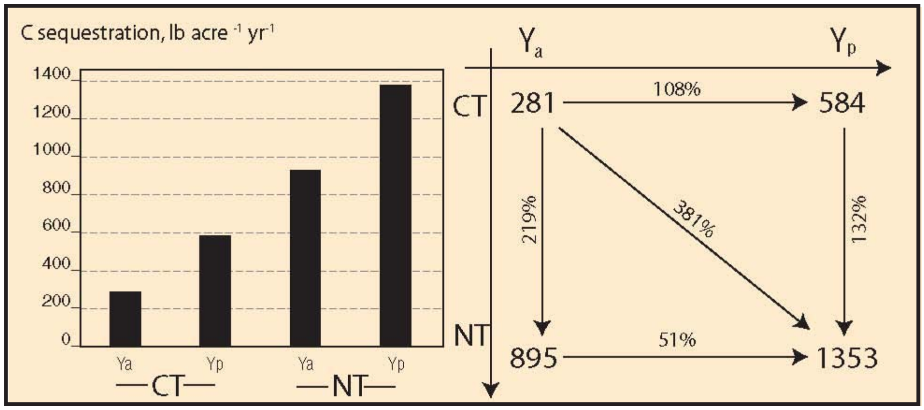

Figure 2. Annual C sequestration over 20 years as infl uenced by corn productivity and tillage method. Absolute annual rates are shown (left). Values (right) are absolute annual rates (lb C/A/yr) while percent increases are shown for effects of tillage and yield. Ya = actual yield; Yp = yield potential; NT = no-till, CT = conventional-till.

Using data from the University of Nebraska Carbon Sequestration Program as reported in Table 2, which includes the actual energy values for all inputs used in producing the corn as well as the energy costs of transportation to the ethanol plant and in conversion to ethanol, we found a large net energy surplus equivalent to 215 gallons of diesel fuel equivalent per acre for irrigated corn, and 166 gallons for rain-fed corn. If we assumed yield levels obtained in this study on 25 percent of the irrigated corn area in Nebraska could produce about 1.7 billion gallons of diesel equivalent, that would be enough to meet the annual fuel requirements for all the cars and trucks in Nebraska, Iowa, and Kansas combined. Moreover, the high NUE achieved in the study would reduce losses of N to the environment by a substantial margin compared to today's average farmer.

Advantages of fluids

Fluid fertilizers have a number of advantages in seeking to achieve higher yields and nutrient efficiency while reducing greenhouse gas emissions. They allow more precise nutrient balance and placement to meet crop demand and to maximize root contact--especially during the critical early crop establishment phase. Fluid N formulations reduce reliance on anhydrous ammonia, which has the greatest potential for losses via denitrification to nitrous oxide—the most potent of all greenhouse gases. When used for fertigation, fluids typically increase NUE substantially by achieving greater synchrony between crop N demand and the N supply, thus avoiding excess available N vulnerable to loss.

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