USING SPATIAL DATA ANALYSIS TO COMPARE ROTATED AND CONTINUOUS CORN SYSTEMS OVER TIME

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Tackling a unique situation often requires a unique approach. For years, university research has with almost complete consistency shown yield penalties associated with growing corn following corn, as opposed to planting corn in a rotation with soybeans or another crop. At the same time some growers are achieving some of their best yields growing continuous corn. Some think that successive high-yielding corn crops cause fundamental changes in the soil, leading to a different, higher-productivity environment for the crop. This article summarizes the argument for considering long term continuous corn and it outlines a method for testing the agronomic and economic potential of this cropping system.

For those growers touting their success with continuous corn, some of their techniques involve managing crop residues with fall nitrogen and tillage, maintaining high P and K levels in the soil, adequate amounts of applied nitrogen, and high plant populations. Mark Dempsey of Fowler, IL seems to have perfected the recipe. A field of Dempsey's that has been in corn for four years yielded 320 bu/A in 2004, enough to place second in the National Corn Growers Contest, highest in Illinois. That was quite a feat with the record yield levels and over 3,000 entrants in that contest nationwide. A modest Dempsey credits much of the success to the weather, and insists his management practices were not that extraordinary.

"We used 230 lbs N, 90 lbs potash and 60 lbs phosphate (as DAP)," Dempsey said. "We bumped the population to 44,000. Our post herbicide actually went on late."

While there's a trend to reducing tillage in other systems, primary tillage seems to be a key part of the winning recipe in long term continuous corn.

"It's unbelievable the amount of residue from a 300+ bu/A field," Dempsey said, and added that residue, and managing it, is a key element in success. "We apply 30 lb/A N as liquid in the fall to help break down the residue, and pull a mini-moldboard plow at a depth of about 14 inches. That mixes the residue with the soil but still leaves the surface mostly intact," said Dempsey. Dempsey gives a lot of credit also to the pattern tile drainage that he has installed in certain fields, which allows soils to warm and dry, allowing more timely tillage and expediting residue decomposition.

Adding to the interest in growing continuous corn is that many growers have been relatively more pleased with their corn crops as compared to other crops, especially soybeans. There are many reasons for this, but include the following:

- Corn is yielding relatively better than soybeans compared to years past. Since the 1960s U.S. soybean yields have trended upward at slightly less than 1 percent per year (about 0.4 bu/A/yr), with corn increasing at about 1.3 percent per year (1.8 bu/A/yr). Last year both crops set records, but in the last ten years soybeans have lagged, increasing at just 0.2 bu/A/year while corn has gone up 3.4 bu/A/year. Most of that drastic difference is due to the dismal soybean yields of 2003, but even taking that out, soybeans still lag corn. Forty years ago soybean yields were typically 33% of corn, but now soybean yields are about 28% of corn yields.

- Soybeans have suffered from an array of pest problems, including soybean cyst nematode, sudden death syndrome, and leaf aphids. Now, Asian soybean rust has many wondering about the additional costs and risks of growing soybeans.
- Rotation with soybeans is not solving corn rootworm problems in huge areas of the Eastern Corn Belt where the western rootworm variant is spreading.

Comparing the dollar contributions of corn and soybeans in rotation for a typical farm, corn and soybeans have traded off over the years, fluctuating with grain prices, weather conditions, and other factors. Corn usually far exceeds soybeans for gross returns, but corn is also more expensive to produce and harvest, with increased fertilizer, pesticide, drying, hauling, and storage costs, evening the slate with soybeans. In contrast continuous corn has never provided a greater contribution than either rotated corn or soybeans in the last several years of Purdue analyses, as it has been difficult to recoup the 10% yield penalty that most agree is associated with the first year of corn following corn, and the additional fertilizer and pesticide costs. For farms where there is high demand for livestock feed, especially silage, the situation can be different.

University research, with few exceptions, doesn't support the idea that corn on corn yields can match rotated. The rotation effect has been known for as long as crops have been cultivated, but many of the reasons remain a mystery. Differences in soil fertility, crop residues, and insects, weeds, and diseases can be partially responsible. But even when these factors are eliminated, there often remain unexplained yield differences. In a literature review of all known published data comparing continuous corn to a corn soybean rotation, rotated corn beat continuous corn in all but two of the studies. Some growers contend that their second year of corn is the most challenging and that yields recover in subsequent years, but there was no evidence of any relative yield improvement over time in any of the long-term researcher managed studies (see literature review at http://www.agecon.purdue.edu/pdf/Crop_Rotation_Lit_Review.pdf).

Some long-time continuous corn growers and university specialists feel that a unique situation can develop over time in high-managed continuous corn. The factors that they feel are significant include:

1. Increases in soil organic matter. Corn produces more biomass than soybeans, and unless harvested for silage studies have shown continuous corn production can significantly increase soil organic matter. Increases of 2 or 3 percentage points have been documented in situations where there have been many years of continuous corn. Conversely, a decline in soil organic matter is well recognized in cropping systems that include soybeans. However, the high amounts of biomass produced by corn must be managed. No-till continuous corn has not been a successful option. Primary tillage is needed to provide soil mixing and aeration to promote the conversion of crop residue into stable soil organic matter.

2. Increases in soil quality. Increased soil organic matter, with limits, positively influences a number of other factors including soil structure, buffering capacity, water-holding capacity, and microbial activity, among others.
3. Increases in available nitrogen. Nebraska studies show long-term continuous corn builds soil N. In contrast, a corn/soybean rotation with typical fertilization rates actually results in a net long-term loss of nitrogen in the soil. There is a limit to how much nitrogen soybeans fix through symbiotic means, as high-yielding soybean and corn crops remove huge quantities of nitrogen.

Continuous corn farmers Herman Warsaw, Francis Childs, and Mark Dempsey would likely agree. The late Herman Warsaw of McClean County, Illinois was the first corn grower to break the 300 bushel barrier in 1975. He did it with long term continuous corn. Six-time national NCGA non-irrigated champion Francis Childs of Iowa broke the 400 barrier in 2001 with long term continuous corn. The two 300+ non-irrigated yields in the 2004 NCGA yield contest were Childs and relative contest newcomer Mark Dempsey, all corn following corn.

Some say the reason why university research has not been able to replicate the results that some farmers are achieving with continuous corn is that university studies have been conducted at normal levels of management—or that these systems may be unique to soil types or regions. Also, the university studies were conducted in small plots, ideal for many kinds of studies, but not ideal when testing long-term effects and varying crop rotations where there can be significant edge effects.

To evaluate the potential of continuous corn systems, we are proposing to work with growers who would compare a continuous corn system to a corn/soybean rotation in adjacent fields or adjacent blocks within fields. Both cropping schemes would be at a high level of management in an attempt to achieve exceptional yields, and to test methods distinct to continuous corn that could lead to the development of a unique biosystem capable of out-producing a competing corn/soybean rotation system. Data analysis will use spatial methods to compare agronomic characteristics and the profitability of continuous corn and rotation systems.

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