Do farming practices affect corn and soybean quality traits?

Center for Integrated Agricultural Systems • UW-Madison College of Agricultural and Life Sciences • August, 2004

Research Brief #70

Grain farmers can help the environment by expanding their corn-soybean rotations to include additional crops. Research has shown that expanded rotations can reduce the need for pesticide and herbicide applications by breaking the life cycles of insects, weeds and diseases specific to corn and soybeans. In addition, grain yields often increase in the longer rotations. Can expanded grain rotations also result in an increase in specific grain characteristics to generate more income?

The hypothesis for this project was that expanded rotations—with their increased use of organic sources of nitrogen, reduced use of herbicides and altered soil flora and fauna—would be associated with grain traits such as higher protein, oil or starch levels or higher endosperm density. The higher value of crops with these traits could increase incomes for grain farmers using expanded rotations.

Testing this hypothesis were statistician Jon Baldock from AgStat and grain marketer Ron Doetch, formerly with Quality Traders Inc. (QTI) and now with Michael Fields Agricultural Institute; Michael Fields agronomists John Hall and Jim Stute (now with UW Extension in Rock County); and Josh Posner and Janet Hedtcke of Agronomy at UW-Madison. This study builds on the Wisconsin Integrated Cropping Systems Trial (WICST).

WICST research compares yields, profits and environmental impacts from three grain cropping systems and three forage systems at two Wisconsin sites. WICST studies whether increasing the complexity of a crop rotation can decrease reliance on purchased inputs without reducing profitability. (See *Research Briefs* 43, 44 and 53.)

WICST sites at Arlington and Elkhorn (Lakeland) as well as other plots provided the corn and soybean samples for this study (see the chart of results on page 2). All samples were dried and tested for grain quality (protein, oil, starch and kernel density) using Near Infrared Transmittance technology.

Corn trials

The researchers collected samples of corn from 20 (2000) and 33 (2001) farms near Sunrich, Minnesota, growing a QTI corn hybrid. The hybrid is noted for its high protein and oil content. The samples came from a range of corn-based rotations and management systems using different fertilizer rates, herbicides and tillage. Grain quality traits including percent protein, oil and starch, and endosperm density were stable across this range of environments.

In a second study, researchers evaluated a range of corn hybrids for yield and grain characteristics under various agronomic practices on land adjacent to the WICST trials at Lakeland. The ten hybrids were planted following either corn or soybeans, with two different N fertilization rates and three planting populations. "In this trial," explains Doetch, "there was a difference between specific hybrids for percent protein and oil. Previous crop planted, N-rate, and planting population did not affect grain characteristics for any of the hybrids."

Some grain composition traits were affected by cropping system in the 2001 WICST trial at Lakeland and 2002 trials at Lakeland and Arlington. In 2001, the corn at Lakeland from the two nitrogen-rich rotations that included alfalfa and manure had higher protein levels than the corn from grain-only rotations. In 2002, at both sites, corn grown organically in the grain-only rotation had lower protein than in the organic forage-based system, and lower protein than corn grown in the continuous corn and no-till corn and soybean systems. This result, according to Posner, suggests that

Markets based on grain composition offer new income possibilities.

Summary of Corn and Soybean Traits Under Different Management Systems

Crop/Year	Location	Traits tested	Management system	Differences
Corn 2000, 2001	Sunrich, MN	% Protein, oil, starch, endosperm density	53 farms all planted the same corn hybrid with different rotations, fertilization rates, herbicide application rates and tillage levels.	Grain characteristics were very stable in these high output environments and no differences were found.
Corn 2001	Lakeland	Yield, % protein, oil, starch and endosperm density	Ten hybrids either following corn or soybeans, with 2 N-fertilization rates (120 and 160 lbs/a) and 3 planting populations (33K, 30K, 27K plants/a)	Although % protein and oil varied by hybrid, there was no effect of previous crop, N-fertilization or planting density on grain characteristics.
Corn 2001, 2002	Lakeland and Arlington WICST plots	Yield, % protein, oil, starch, endosperm density, and 300 seed weight	Five corn production systems. Grown in forage-based systems with alfalfa and manure and in grain only systems.	Rotations that included alfalfa had higher % protein and greater endosperm density. In organic systems, rotations with alfalfa had higher yields and % protein than in organic grain systems.
Corn 2002	Arlington	Yield, % protein, oil, starch, endosperm density and 300-weight count	Four continuous corn systems. With manure vs. N-fertilizer and high vs. low soil test P and K.	Main difference was that manured treatment was higher for 300-weight count. Low P & K fertility with added N had lower yields but higher protein than fields at high fertility level.
Soybeans 2001	Arlington Research Station (Lauer)	% protein and oil	Three soybean rotations (5 years soybeans; 1st year soybean after 5 years corn; alternate corn/soybean), 2 tillage systems (no-till and conventional); and 2 row spacings (drilled and 30-inch rows)	Changes in grain quality traits were so small as to have no economic significance. Highest protein in continuous soybeans. Highest oil in soybeans following corn. Conventional tillage had higher % protein; no-till had higher % oil.

the tight three-year organic grain rotation with only a single season of red clover cover crop plow-down is nitrogen deficient.

The researchers also looked at the effects of soil test levels and nitrogen fertilization on grain traits in a monoculture corn production system on two fields at Arlington in 2002. One field was divided into two sections with half fertilized with manure and the other half spread with synthetic fertilizer. The other field was fertilized with 160 lbs. N/acre, but one half of the field had very low soil test levels of phosphorus and potassium, and the other had high levels. There were no differences between corn fertilized with manure and synthetic fertilizer except for the 300-seed weight, which was significantly higher for the manured corn. The low phosphorus and potassium fertility treatment, as expected, produced low yields but, due to N-fertilization, elevated protein levels when compared to the optimum soil test plots which gave high corn yields.

Soybean trials

The researchers collected soybeans in 2001 from a 20-year corn/soybean rotation trial conducted at Arlington by UW Agronomist Joe Lauer. They took samples from different rotations, tillage systems and row spacings.

"While we found statistical differences between crop rotations for grain traits, they were so small as to have no economic significance," Hedtcke says. The highest protein levels were unexpectedly found in continuous soybeans, and first-year soybeans following corn had the highest oil level. Conventional tillage resulted in higher protein levels, while no-till yielded higher oil levels; row spacing had no effect.

Conclusion

"During this exploratory study, several grain composition traits were not affected by crop rotation," reports Posner. However, it appears that choosing a hybrid selected for specific value-added traits can make an economic difference. Future work will focus on selecting hybrids or varieties with known marketable characteristics to see if these specific, subtler, traits are enhanced by expanded crop rotations.

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