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Wheat in Ontario rotations increases row crop yields and profits

By Matt Ernst

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A new study analyzed yield and return impacts of wheat in rotations at Elora and Ridgetown (study site shown here), ON, Canada. Photo courtesy of Dave Hooker.

Producers may hesitate to add wheat to corn–soybean rotations because of wheat's comparatively lower net returns. But a well-managed wheat crop potentially increases returns from rotated row crop systems, mainly because of corn and soybean yield boosts after wheat, according to new research in *Agronomy Journal*. The study analyzed yield and return impacts of wheat in rotations at Elora and Ridgetown, ON, Canada and underscores the importance of analyzing returns from the entire crop rotation cycle.

Producers may hesitate to add wheat to corn–soybean rotations because of wheat's comparatively lower net returns. But a well-managed wheat crop potentially increases returns from rotated row crop systems, mainly because of corn and soybean yield boosts after wheat, according to an analysis published by University of Guelph researchers in a recent issue of *Agronomy Journal* (**https://doi.org/10.1002/agj2.20605**).

The study analyzed yield and return impacts of wheat in rotations at Elora and Ridgetown, ON, Canada. "We documented that corn and soybean yield response associated with including wheat in rotations seems to be increasing with time," says Ken Janovicek, research assistant at the University of Guelph Department of Plant Agriculture.

Cumulative net returns at Elora were 10% greater for a corn–corn–soybean–wheat rotation (CCSW) than for corn–corn–soybean–soybean (CCSS) rotations. “We found the revenue gain in the rotation crops more than offset any revenue lost in the wheat year, at Elora,” Janovicek says.

The gain came from yield boosts. “We demonstrated that corn and soybean yields are more resilient in rotations with wheat, especially in stress years, and that results in potentially greater net returns for the whole system,” says Dave Hooker, associate professor of plant agriculture at the University of Guelph Ridgetown Campus. He and Janovicek co-authored the study with agricultural economists Alfons Weersink and Richard Vyn, and Bill Deen, a retired plant agriculture professor.

Bottom Line Benefits over Time

Higher corn and soybean yields (Table 1), in rotations with wheat, accounted for higher net returns at Elora. The average returns for four-year rotations with wheat at Elora increased by $16 per hectare per cycle (about US$12.60, or $5.10 per acre) relative to continuous corn. Relative to a CCSS rotation, the average rotation return for wheat was $10 per hectare per CCSW cycle (about US$7.90, or $3.20 per acre).

Table 1. Impacts of wheat in rotation at Elora, ON, Canada by tillage system (2002–2017).

	Yield increase with wheat in rotation
Conventional first-year corn yields, with red clover	6.8 bu/ac (0.43 Mg/ha)
Conventional second-year corn yield, with red clover	15.6 bu/ac (0.98 Mg/ha)
No-till first-year corn yield	12.4 bu/ac (0.78 Mg/ha)

	Yield increase with wheat in rotation
No-till second-year corn yield	7.1 bu/ac (0.45 Mg/ha)
First-year soybean yield	5.4 bu/ac (0.34 Mg/ha)

At Ridgetown, researchers compared net returns in a three-year CSW rotation and a CS rotation. Their analysis showed statistically similar net returns between the two rotations at Ridgetown where a 104-day growing season produces historically higher corn and soybean yields than at Elora with a season length of 84 relative maturity days. “When we looked at the Elora and Ridgetown trials together, we concluded that including wheat into rotations once every four years can increase overall returns compared with when included in rotations more frequently,” Janovicek.

Soil Health and Stress Tolerance

At Elora, a four-year rotation with wheat produced the greatest first-year corn yields, relative to continuous corn and CCSS systems. Researchers think such yield benefits start in the soil. At both Elora and Ridgetown, rotation sites that include small grains have superior organic matter, soil structure, and soil health scores. “We think that’s contributing to the difference between wheat rotations and just corn and soybeans, and maybe the differences in soil structure are becoming greater over time,” Janovicek says.

Wheat rotations especially pay off during years that are water-stressed around silking for corn and early- to mid-reproductive stages for soybeans. “At both Elora and Ridgetown, the biggest rotational responses are in dry years or stress years,” Hooker says. “The soil differences can explain some of these crop rotation benefits in stress years. We think the resilience against drought stress is helping to increase the yields, and becoming more important, as genetic yield potential increases.”

Planting red clover into the wheat stubble and maximizing straw returns are important factors for wheat’s net return impacts, according to the study. Photo courtesy of Dave Hooker.

These data can help reassure crop producers and advisers wondering if including wheat is really “worth it” over time. “Most growers realize that corn and soybeans perform better in a wheat rotation. But 10 or 15 years ago, it was not quantified very well. Now, we have good consistent numbers, and our results jive very well across two quite diverse growing environments along with observations across farm fields,” Hooker says.

Maximizing Wheat Returns: Straw Sales and Intensive Management

Harvesting straw can help producers increase wheat net returns. Accounting for nutrient removal and assuming straw sales of nearly 3,600 lb/ac, the researchers found straw sales could boost wheat net revenue as much as US$112/ac (CAN$220/ha). “Some producers say, ‘If you remove the straw, you reduce the potential benefit,’” Janovicek says. “But almost all years at Elora, the wheat straw was baled off, and we are documenting yield responses when you include wheat in the rotation with no straw

return (to soil)."

There were differences in straw's contribution to net returns between the two sites. At Elora, wheat straw sales in the four-year rotation increased net returns by an average of $28/ac for the four-year rotation. At Ridgetown, straw sales increased net returns by about $56/ac and $37/ac for the two- and three-year rotations with wheat, respectively.

The wheat crop must be intensively managed to realize the net return benefits to the rotation system. "Wheat should be managed as intensively as corn and soybeans usually are managed. The benefits of having wheat in the crop rotation won't look very attractive when low wheat yields occur because of poor management," Hooker says. "We talk all the time in Ontario about wheat intensification: like putting down phosphorous in-furrow at planting, early and timely planting, fungicide application at heading, uniform plant stands. You have to manage that wheat crop as intensively as you manage your corn and soybeans to see the benefits to net return."

Maximizing Wheat's Impact: Cover Crops

In northern regions, it is easier to successfully include cover crops after wheat, relative to corn and soybeans, because there are two or three more months with favorable cover crop growing conditions. Planting red clover into the wheat stubble and maximizing straw returns are important factors for wheat's net return impacts, according to the study.

The Ridgetown study, including data through 2019 that were not included in the published study, points to yield benefits from a red clover cover crop. "When we include 2019 data, we find at Ridgetown, the red clover provides an additional 6.7 bushels more corn per acre compared with no red clover," Hooker says. "This is over

and above any nitrogen contribution." The study did not assume any rotation N credits to corn from the red clover in the economic analysis, which in Ontario, is 63 lb N/ac, valued at $48.

Red clover's impact varied between tillage systems. "At Elora and Ridgetown, the major yield benefit is within the conventional tillage system," Janovicek says. "Red clover doesn't seem to have the benefit when it's included in the reduced-till system. In fact, in the no-till trials at Elora, red clover seemed to reduce the yield a bit."

Janovicek notes that some producers could harvest the red clover, or a later-seeded cover crop like oats, for forage. That could add additional economic benefits; a 2019 study reported oats planted following wheat harvest at Elora can produce 1,790 to 3,600 lb/ac of high quality forage.

Whole-Farm Impact

The research underscores the importance of analyzing returns from the entire crop rotation cycle. "You have to look at the system as a whole, not just what one year in a rotation is returning," Janovicek says.

Beyond the agronomic and economic benefits demonstrated by this research, adding a third crop into an existing corn–soybean crop system can provide benefits not so easily measured but easily recognized by CCAs and the producers they advise. One is planting time. "The last corn and soybean fields planted in the spring are usually the ones with a yield penalty from late planting," Hooker says. "If you can divide your total area between three crops instead of two, it can be easier to plant spring crops in a timely manner. That's a very important piece of this system, that is accounted for in the trials."

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View the original *Agronomy Journal* article, "Corn and Soybean Yields and Returns Are Greater in Rotations with Wheat," at **https://doi.org/10.1002/agj2.20605**.

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Back to issue

Back to home