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WHAT TO EXPECT FROM THE NITROGEN USE EFFICIENCY TRAIT IN CORN

The future demands crops that will produce more food using less N. Corn is one of the most productive cereals, producing a lot of carbohydrate per unit of N applied. Several plant breeding companies have set goals to substantially increase the N use efficiency of their future hybrids. How will these differ from the hybrids of today?

Corn producers have already improved N use efficiency. This doesn't necessarily mean less N per acre. In the past 40 years in the Corn Belt, the amount of corn produced per unit of fertilizer N applied has increased by 78%, while N rates went up 30%.

How has this improvement in efficiency been achieved? Mainly by increasing yields, associated with:

- Greater N uptake, extending later into the season;
- Increased internal efficiency in the plant, yielding more grain per unit of N taken up;
- Small reductions in the crude protein (N) content of the grain.

Plant breeding companies have ramped up efforts to continue genetic improvement. Both conventional and biotech approaches are being applied. What are the traits that might contribute?

- Further increases in yield and tolerance to stresses like high plant populations;
- Roots that explore the soil more quickly and thoroughly;
- Transporters that assimilate nitrate and enzymes that convert it to amino acids more efficiently;
- Altered patterns of storage and remobilization of N within the plant;
- Ultimately, symbiotic N fixation—but that's an unknown, and a long way off.

These traits may require changes to the way nutrients are managed for corn. What will the right choices look like for source, rate, timing, and placement?

Source – Corn will likely continue to take up N as ammonium and nitrate. Physiologically, it takes the plant less energy to make protein from ammonium than from nitrate (even though corn is efficient at using nitrate). Increasing ambient carbon dioxide also favors ammonium uptake. Corn may start showing more preference for ammonium. So perhaps we can envision using sources that slow or prevent the conversion of fertilizer into nitrate, keeping it as ammonium later into the growing season.

Rate – Plant breeding won't likely improve our ability to predict what the soil might provide, or what the weather might remove from the soil by leaching, denitrification or other loss routes. These factors will likely remain the main determinants of the optimum rate to apply, though when yields increase some account will have to be made for increasing plant demand for N as well.

Timing – The corn plant needs N from start to finish. European studies show that continued N uptake beyond even a typical silage harvest date can be important for grain yield. Can we find ways to split the dose or control release for effective N uptake over a more extended period of time?

Placement – Could we envision a root trait that changes the depth from which N is captured? Roots operate most efficiently within the topsoil. It will still be important to get the applied N into that zone. But could we place other nutrients—like P and K—in a way that helps express the full potential of a NUE trait? Can we envision a trait that proliferates roots in zones where nutrients have been banded in ways that minimize losses to water and air?

There are good reasons to expect more genetic improvement of N use efficiency in corn. To make the most of it will require more agronomic experimentation with plant nutrition as well.

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Abbreviations: N = nitrogen.

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