Commercial Maize Seeding Rates Look to Have Hit a Ceiling

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AS WITH other agricultural inputs, the choice of crop seeding rate involves tradeoffs. While seed comes with genetic, coating and other resources that positively affect yield, use of some resources essential to plant growth are determined by plant density. Each unit of land makes available nature-given stocks of nutrients and sunlight. In many cases these stocks can be supplemented with irrigation and applied plant food (i.e., fertilizer). The seeding rate choice trades off the number of plants per acre with the yield produced per plant where production per plant at higher plant density will decline because a smaller share of resources available per acre are available per plant. When highest profit per acre is the goal then two factors weigh in favor of choosing a low seeding rate, these being cost of seed and higher production per plant, while having production from more plants weighs in favor of choosing a higher seeding rate.

From the mid-1990s through the early 2010s, US corn producers steadily increased seeding rates. Figure 1 shows US-level acreage-weighted corn seeding rate between 1995 and 2022. A steady increase from about 26,000 seeds per acre to about 31,000 seeds per acre occurred over the 1995–2015 period, which was an overall increase of about 19%. Visual inspection suggests little growth in seeding rate since 2015. Noteworthy is that around about 2015, seed companies stopped increasing their on-bag seeding rate guidance.

We fitted a regression line to the data in figure 1 where we allowed the slope to differ between the 1995–2014 and 2015–2022 time windows. Estimation results show that seeding rate increased by an average of 254 kernels per acre per year between 1995 and 2014, but the growth rate slowed significantly to just 18 kernels per acre per year after 2015. Perry et al. (2022) estimate that a reduction of 625 seeds per acre in planting rate leads to a yield decrease of approximately 1 bushel/acre. Based on this relationship, the cumulative slowdown in seeding rate growth is projected to have potentially resulted in a yield loss of approximately 4.15 bushels per acre from 2015 to 2025 by farmers not using this pathway to increase yields. Associating a change in seeding rate with change in yield is a perilous business, if only because the decline in seeding rate may be compensated for by changes in seed attributes or by other farmer choices, and also because yield outcomes depend on many stochastic factors that confound attribution of cause. Figure 2 shows acreage-weighted average yield over the same time frame shown in figure 1. Upon running a regression using the figure 2 data, we did not find evidence of a change in yield trend at around 2014–2015. Others, however, have found a break in US maize yield trend (and soybean and wheat too) around about 2013 (Boussios 2025).

One way to think about why this levelling off in seeding rate has occurred is to note that during the duration when seeding rates increased, plant breeders, agronomists and agricultural engineers found ways to make more resources available for uptake by the farmed crop. Resources already available were freed up, perhaps through cultivation and drainage choices or through applying herbicide so that scarce resources that would have been consumed by weeds become available to the growing crop. Herbicide tolerance traits allow for more efficient removal of weeds that compete for plant resources. Other traits, such as *Bt*, reduce insect feeding that could

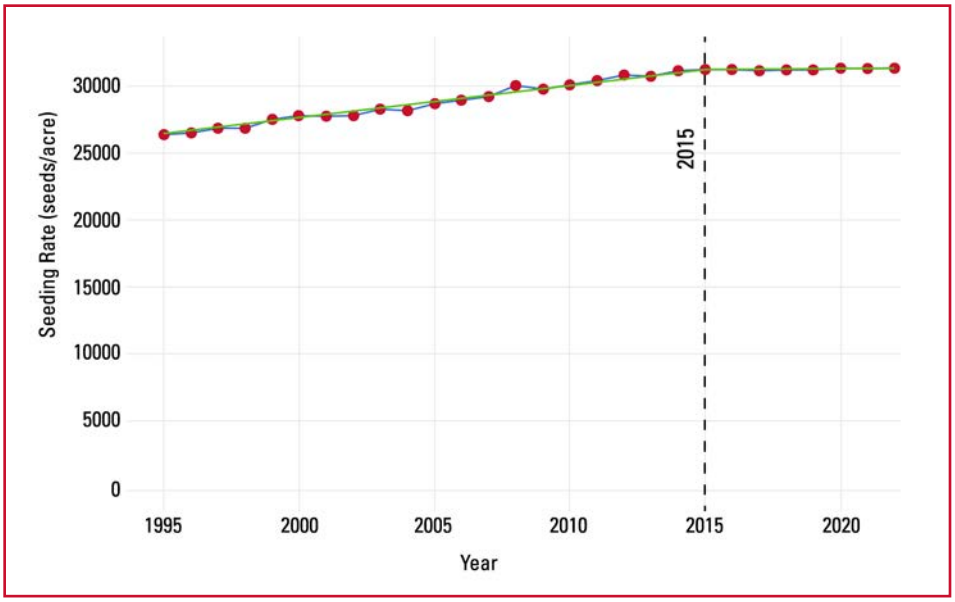

Figure 1. US weighted average of maize seeding rate, 1995–2022.

Source: TraitTrak of Kynetec, a commercial agricultural dataset that provides detailed information on maize seed varieties and planting rates across the United States.

impede nutrient uptake and transfer by the plant. Resources could also be added to the soil by applying more nutrients to offset experienced per-plant yield reductions due to increased plant density. Another possibility is that modern hybrids have been developed in ways that allow them to better use available resources (improved efficiency), enabling greater yield production per unit acre even when plant number per acre is held constant. In all cases, allowing the plant stand to access more resources may allow more plants to be sown.

The critical resources for plant growth are carbon dioxide, oxygen, the right temperature, water, nutrients, sunlight and space to grow. Of these, carbon dioxide and oxygen are generally in ample supply and are difficult to manage for crops grown in the open air. The right temperature can be determined by the choice of growing season when the crop is suitable for a location. Nutrients, and perhaps water too, can be supplemented if in short supply. Sunlight and space to grow are most affected by planting dates and seeding rate, and have been the topic of much maize plant breeding activity over the past half century or more.

The goal of these activities has been to arrive at a plant architecture involving more erect leaves in the upper canopy. Historically, it was thought that earlier hybrids had upper canopy leaves that were too horizontal for the whole plant to efficiently catch sunlight and also because leaves stretching out limited capacity to seed at higher rates. In considering Bayer Seed Company's legacy hybrids over the 1980–2020 time frame, Elli et al. (2023) conclude that, when averaged across the whole plant, leaf angle became 6 degrees more vertical over the period, and also that higher plant density both complemented and promoted this movement toward the vertical. Their analyses also deduce that leaf angle may now be very close to optimum in terms of catching and converting sunlight into plant yield. Intuition suggests that the leveling off of commercial maize seeding rates is related to convergence on the optimum leaf angle ensemble. Whether and how these patterns are connected to a possible decline in the rate of growth in maize yield is not clear.

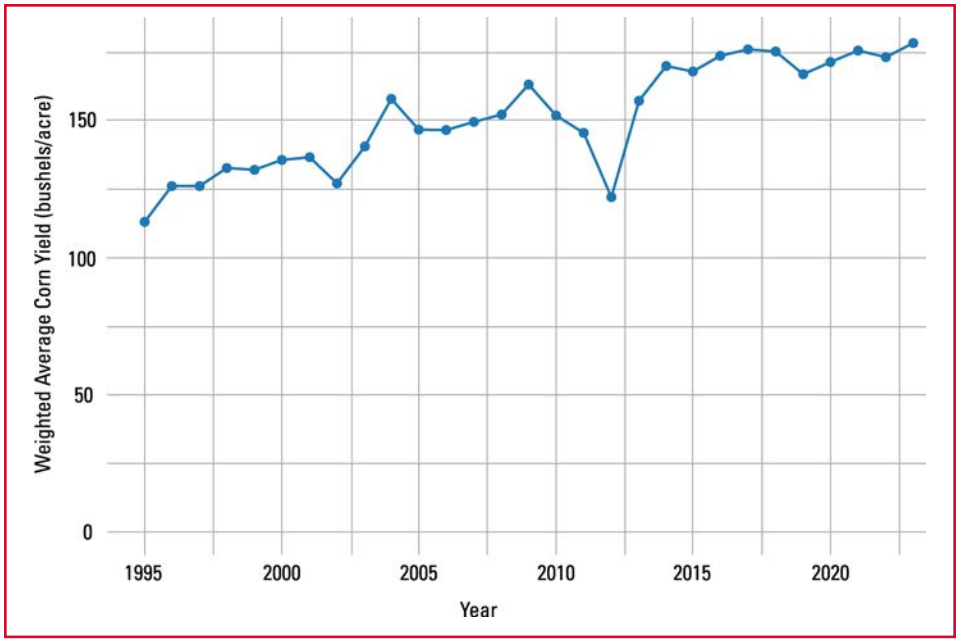

Figure 2. US weighted average of per-acre yield, 1995–2022.

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Suggested citation

Zhao, Y., D.A. Hennessy, and A. Lindsey. 2025. "Commercial Maze Seeding Rates Look to Have Hit a Ceiling." Agricultural Policy Review, Spring 2025. Center for Agricultural and Rural Development, Iowa State University. https://agpolicyreview.card.iastate.edu/commercial-maze-seeding-rates-look-have-hit-ceiling.■