How much can crop yield increase in the future? This question is at the heart of any evaluation of food security issues. One popular approach to answering this involves evaluating the size of the “yield gap”—the difference between potential yield (yield in a perfect environment) and yield in farmer’s fields. Large yield gaps imply that there is more room for improvement than if the gaps are small.

The key to any yield gap analysis is the estimate of potential yield. Researchers have used record or maximum farmer yields, yields from well-managed experiments at agriculture experiment stations, or estimates from crop simulation models. In a paper published in the March–April 2014 issue of *Agronomy Journal*, farmer yields in years with the most favorable weather conditions over a 40-year period were used as an estimate of potential yield for a particular location. County soybean yields (reported by the National Agricultural Statistics Service) from Kentucky, Iowa, and Nebraska (irrigated only) were used to provide a range in yield in an area with little variation in economic conditions or availability of technology. A quantile regression analysis set at the 95th percentile was applied to county yields within each state from 1972 through 2011 to estimate the attainable potential yield (APY) and the yield gap (YG) (APY – county yield) for each year of the 40-year period. A second YG was calculated from the variation in mean county APY within each state.

There was substantial variation in productivity (mean county yields, 1972–2011) among the three states and counties within each state. The average yield of the highest-yielding county in Kentucky (265 g m$^{-2}$) and Iowa (316 g m$^{-2}$) was approximately 40% higher than the lowest-yielding county. The difference in the low-stress environment in Nebraska was much less (335 to 286 g m$^{-2}$, a 17% difference).

Year-to-year variation in county yield was larger in counties with lower yields. Yield in these counties suffered large reductions in years with unfavorable weather conditions while reductions were much smaller in the high-yield counties. Consequently, the size of the yield gaps increased as the mean (1972–2011) county yield decreased. The larger YGs in years with unfavorable weather (low rainfall) may indicate that soil water-holding capacity was limiting. Soils with larger capacities would be better able to withstand low rainfall, and the yield gaps would be smaller. The average (1972–2011) relative yield gap (RYG = YG/APY) varied from 9% in the highest-yielding counties to nearly 24% in the lowest-yielding counties in Kentucky and Iowa (16% in Nebraska).

The variation in RYG among years was substantial, reaching maximum levels of 50% or more in some years (30% in Nebraska), but there was little evidence in Iowa and Kentucky that the size of the relative yield gap was changing with time. Nearly half of the counties in Nebraska, however, showed a significant decrease. The reputed increase in stress tolerance of modern cultivars was not evident in Kentucky or Iowa; perhaps any improvement was offset by an increasingly stressful environment.

The second YG [maximum mean (1972–2011) APY in a state minus any county mean APY] defined a gap that occurred in the most favorable environments during the 40-year period. This YG represented a considerable difference in yield; the lowest APY was approximately 19% less than the highest in Kentucky, 24% in Iowa, and 10% in Nebraska. Soil water-holding capacity was probably not as important for this YG; instead variation in the application of technology by the farmers or other soil characteristics may have played a significant role.

Soil characteristics seemed to play an important role in defining the YG in these production systems. Irrigation should reduce the first YG in many counties in Kentucky and Iowa. Reducing the second YG associated with variation in APY among counties may be possible to the extent that it is related to management, but it may be relatively intractable if it is related to soil quality.


doi:10.2134/csa2014-59-4-3