How '16 weather affected yields

Corn Source

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HARVEST is complete, 2016 yields and management are being critiqued, and plans are starting to take place for next year. The November USDA crop report is estimating a 2.69 billion-bushel corn crop for Iowa. This would set a record for bushels produced, as well as a record-high yield of 199 bushels per acre.

By this standard, some people may think there is no need to look back at 2016 weather and management. Not so fast! This year could be characterized into two time frames. June was warmer and drier than normal. July and August were cooler and wetter than normal. The weather was extreme to the point where in southeast Iowa there was concern with crop stress reducing yields even before pollination had occurred. In north and northeast Iowa, rainfall totals in August and September reached extreme levels.

With some extreme weather conditions causing anxiety, it's important to look back on the growing season. It's also important to understand how well decision support tools and other technologies performed. Doing this type of assessment can then be used to determine what steps need to be taken in the coming growing season. To do this we've launched FACTS — Forecast and Assessment of Cropping sysTemS — to understand how complex interactions between crops, soils, weather and management influence grain yields and soil nutrient dynamics.

We will focus on 10 corn systems at six locations across Iowa. On the website *crops.extension.iastate.edu/facts,* there is more information available, regarding both the corn and soybean systems.

Reviewing FACTS predictions

In 2016, the FACTS corn yield predictions ranged from 200 to 240 bushels per acre. On average, corn yields were under-predicted by 2.3%. Errors associated with model estimations were related to uncertainties regarding cultivar characteristics, initial soil water conditions, and pest factors, such as insects, weeds and diseases.

However, insects, weeds and diseases were of low incidence and severity. In northeast Iowa, late-season rainfall intensity caused an environment where predicted corn yields were higher than actual

harvested yields, due to in-field ear drop between maturity and harvest.

The important question is: How early during the growing season can we get a good prediction of the final yield? According to our results, the first forecast prediction at planting is a good proxy of the final yield. The prediction error was typically within plus or minus 5% to 10%.

This may be hard to believe, but it is supported by our results in both 2015 and 2016. If this result is confirmed in coming years, this might open new ways of designing and managing cropping systems. The secret for a good forecast early in the growing season is to capture and model accurately the soil water supply and nitrate profile.

What drove 2016 yields?

To understand how weather impacted crop yields, it's important to know the weather during the growing season, as well as weather before planting, which influences soil moisture, temperature and nitrate levels in the soil. Again, the first part of the growing season was dry with 2.3 inches less precipitation on average. The dry June was accompanied by high temperatures; about 10 days in June exceeded 86 degrees F.

The combination of warmer and drier weather in June stimulated concerns for water stress effects to crop growth and yield. However, rainfall accumulation from November 2015 to May 2016 filled or nearly filled the soil moisture profile that compensated for potential heat and water stress. Iowa soils have a plant-available water-holding capacity of about 10 inches in the top 5 feet of soil. That offers a tremendous buffering capacity for early-season dry weather.

June 2016 radiation and cumulative growing degree days were 15% above the climatic average.

These higher temperatures increased the rate of leaf development resulting in greater light interception and dry matter accumulation in June. As a consequence, several locations reached pollination sooner than normal and with less overall vegetative biomass.

Wet second half

The second part of the growing season was wetter with an average of 3.6 inches more rainfall than normal. This additional rainfall ensured non-limiting soil moisture during grain fill. Additionally, accumulated growing degree days were fewer than normal in July and near normal in August. In the end, the shortened vegetative period was compensated with a lengthened grain-fill period with no moisture and heat stress.

In summary, the key point for reaching record corn yield and production levels can be attributed to a full soil moisture profile at planting, more solar radiation and higher temperatures in June, and a cooler wetter grain-filling period.

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What is FACTS?

FACTS is an Iowa State University computer modeling program for crops. It uses a systems approach to forecast and evaluate cropping system performance.

It relies on the APSIM cropping systems model; in-field crop and soil measurements; historical, real-time and forecasted weather conditions; and current management practices to simulate crop growth and predict grain yield, along with nitrogen and water status throughout the growing season.

The FACTS project is located at six locations across Iowa and contains 10 corn systems and 10 soybean systems. Throughout the growing season, 10 forecasts were released biweekly.

	May	June	July	Aug	May	June	July	Aug
	Precipitation difference (inches)				Solar radiation difference (MJ/m^2)			
Northwest	-0.2	-2.9	0.1	-0.4	42.0	110.7	25.5	-22.2
Northeast	-1.4	5.0	1.6	3.0	25.3	102.9	-38.5	-33.3
Central-A	-0.9	-3.7	1.3	3.3	-40.2	134.9	-38.7	-55.3
Central-K	-1.1	-3.9	1.4	2.2	-45.0	133.3	-19.1	-60.5
Southeast	-1.2	-3.5	2.9	3.0	27.1	147.9	-36.1	26.9
Southwest	2.5	-2.4	2.2	1.0	-3.5	-79.7	-47.9	-34.1
Average	-0.4	-1.9	1.6	2.0	0.9	91.7	-25.8	-29.7
	Growing degree day difference				Number of heat stress days, difference			
Northwest	-19.8	110.7	-26.8	-3.1	-1.3	7.5	-2.8	-1.6
Northeast	-22.7	46.2	-37.7	10.1	-0.4	2.9	-4.1	-1.9
Central-A	-1.7	130.5	-12.4	31.4	0.1	11.0	-2.2	-1.3
Central-K	0.0	133.7	-25.9	3.4	0.1	9.1	-3.3	-2.0
Southeast	6.8	118.2	-14.7	61.6	4.0	11.7	-2.0	3.4
Southwest	-40.3	122.3	-52.8	-20.2	-0.4	9.2	-3.1	-0.2
Average	-13.0	110.3	-28.4	13.9	0.4	8.6	-2.9	-0.6

Actual cumulative monthly differences between 2016 and long-term (1980-2016) weather variables across six locations in Iowa. A negative value means that 2016 was below the long-term average and vice versa. Central-A is Ames and Central-K is Kelly.