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2012 Outlook Report:
The Impact of Early Planting on Heat Risk for Corn Pollination

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EXECUTIVE SUMMARY

Due to unprecedented warm weather in the spring of 2012, growers across the Corn Belt had the opportunity to plant corn at some of the earliest dates ever seen. And while there can be weather benefits to planting early, there are other weather related risks associated with early planting that can counter-balance the benefits. The Climate Corporation has performed an analysis of the risks and benefits that an early planting can be expected to provide to a corn crop by decreasing the chances that the crop will experience excessive heat during pollination. This analysis looks at how the pollination temperature benefit of an early planting is expected to vary by region across 11 key corn-growing states.

HIGHLIGHTS

- An early pollination period provides corn growers with a benefit related to lower temperatures during pollination in less than one out of 20 years in most of Minnesota, Wisconsin, Michigan, Ohio and northern Iowa. In these areas, the increased risks of spring freeze or imbibitional chilling associated with an early planting would more than offset any expected yield benefits related to an earlier pollination period.
- Early planting that advances the pollination date by even a single week can decrease the chances of a crop experiencing yield-damaging heat by up to 40% in many locations across Kansas, Missouri, Nebraska and South Dakota.

It is hard to imagine two US corn seasons with more disparate beginnings than 2011 and 2012. Where the 2011 season started cold and wet, 2012 was generally hot and dry. And this difference in spring weather can be seen clearly in the USDA planting progress report data for the two years, with planting progress in 2012 well ahead of the pace seen in 2011. A comparison of planting progress across the 11 Corn Belt states included in our study is seen in Figure 1.

PERCENTAGE OF CORN PLANTED AS OF MAY 13: 2012 AND 2011

State	2012 percent	2011 percent	Change 2011 to 2012
Illinois	95	59	+ 36%
Indiana	93	22	+ 71%
Iowa	90	85	+ 5%
Kansas	90	79	+ 11%
Michigan	60	32	+ 28%
Minnesota	88	42	+ 46%
Missouri	93	73	+ 20%
Nebraska	91	76	+ 15%
Ohio	84	6	+ 78%
South Dakota	79	36	+ 43%
Wisconsin	57	30	+ 27%

Figure 1 : Comparison of State Level Corn Planted as of May 13 between 2011 and 2012, Source: USDA Crop Progress Reports from 2011 and 2012[1]

[1] http://usda01.library.cornell.edu/usda/current/CropProg/CropProg-05-14-2012.pdf

In fact, the spring of 2012 has been so abnormally warm that corn growers in many parts of the country started planting corn earlier than ever before, and many acres were planted before the first crop-insurance-approved planting date for their region (with respect to national average temperature, 2012 experienced the hottest March and the third hottest April since the National Weather Service started keeping records 118 years ago[2]). Growers that started planting before the first approved planting date were taking a risk that a subsequent freeze or subsequent cool, wet weather might kill or severely limit the yield potential of the early planted crop. These growers would be on their own with respect to the costs of replanting because they did not adhere to the federal crop insurance guidelines[3]. But growers who planted early did so because they believed the benefits they could receive from planting early, mainly in the form of an earlier pollination window, outweighed the risks.

The analysis in this report leverages The Climate Corporation's unique weather data platform to provide a quantitative understanding of which parts of the Corn Belt are most likely to see beneficial growing season temperatures as a result of an early planting and in which parts of the Corn Belt the risks of early planting may outweigh the benefits that a grower can expect to receive.

One of the biggest yield risks that a corn plant faces during its growth cycle is excessive heat during pollination. If pollination coincides with a period of high daytime temperatures, those daytime temperatures can cause corn silks to dessicate and threaten pollen viability, leading to reduced pollination efficiency and reduced overall yields [4,5]. Yield potential that is lost at the pollination stage cannot be made up through good weather conditions later in the summer, because each kernel that does not pollinate successfully represents permanently lost yield potential [6].

To better understand the potential benefits growers can get from an early planting, The Climate Corporation performed a study of historical daily maximum temperatures for each of the six weeks from June 17th to July 28th at over 820 weather stations spread across 11 key Corn Belt states. The first analysis performed by The Climate Corporation looked at average daily maximum temperatures as recorded at each station for each of these 6 weeks over the last 32 years (1980 to 2011) and the results of that analysis are shown in Figure 2.

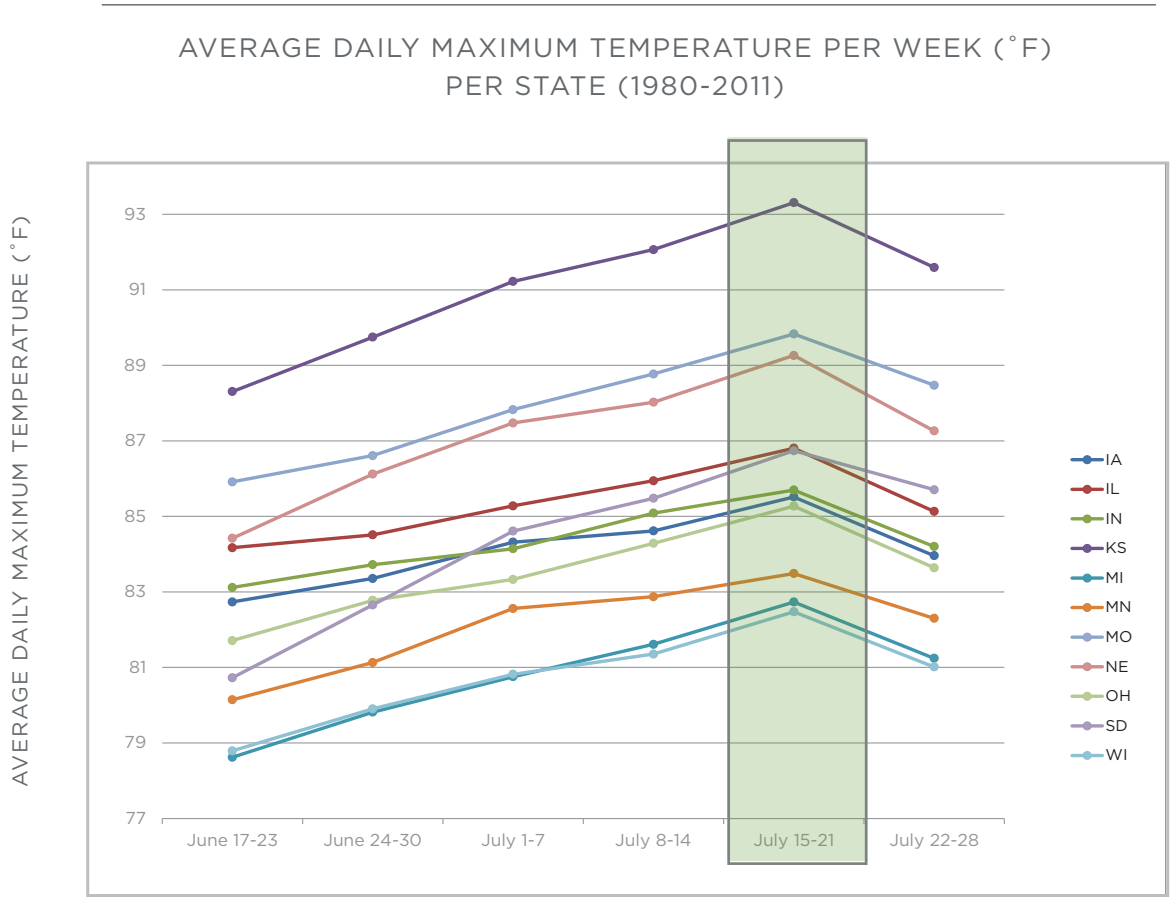

Figure 2: Average daily max temperature per week 1980-2011 in Corn Belt states.

[2] http://www.ncdc.noaa.gov/temp-and-precip/maps.php
[3] http://www.farmdocdaily.illinois.edu/2012/03/impacts_of_planting_before_cro.html
[4] http://www.asgrowanddekalb.com/Agronomy/Pages/Effect-of-Heat-and-Drought-Stress-on-Corn-Pollination.aspx
[5] http://www.fielderschoicedirect.com/wp-content/uploads/2010/07/AgSpotlight-A-Closer-Look-at-Corn-Pollination1.pdf
[6] http://www.uwex.edu/ces/ag/issues/drought2003/corneffect.html

As seen in Figure 2, the peak summer temperatures for all of the eleven states studied have occurred, on average, during the week of July 15-21. To achieve maximum yields, a grower would generally want a corn crop to pollinate prior to this week to avoid what is typically the hottest week of the summer. And though temperatures do get cooler on average after the week of July 15-21, pollinating later than the week of July 15-21 can result in additional yield risks associated with early fall freeze events that can kill the crop before it reaches full maturity and full yield potential.

But to fully understand the temperature-based pollination risks associated with each week of the summer, it is important to look at the absolute temperatures that have been recorded at each station during each week, not just the relative temperatures. Even though the week of July 15-21 has historically been the warmest week of the summer in each of the eleven states, most studies of the impact of heat on corn yields agree that daytime temperatures have to reach the mid-90s before any significant yield impact begins [7,8]. In the northern areas of states such as Michigan and Wisconsin, even the hottest week of the summer rarely produces temperatures in the mid-90s, so pollinating during what is traditionally the hottest week of the summer (the week of July 15-21) does not typically represent a significant yield risk.

To better understand the expected yield benefit that a corn crop in any individual region of these 11 states might receive by pollinating earlier than the week of July 15-21, the second analysis performed by The Climate Corporation looked at the same 32 years of historical temperature data for the same weather stations for the 5 weeks between June 17th and July 21st. An analysis was performed to identify the number of times in the past 32 years each week at each weather station would have been categorized as a Hot Week, where a Hot Week was defined as a week with two or more days of temperatures at or above 95 degrees Fahrenheit. Numerous studies suggest that there must be more than one day of hot temperatures before corn yields start to be impacted [9, 10] (The week of July 22-28 was not included in this second analysis because pollination during that week, while historically cooler, carries significant additional weather related risks associated with an early fall freeze).

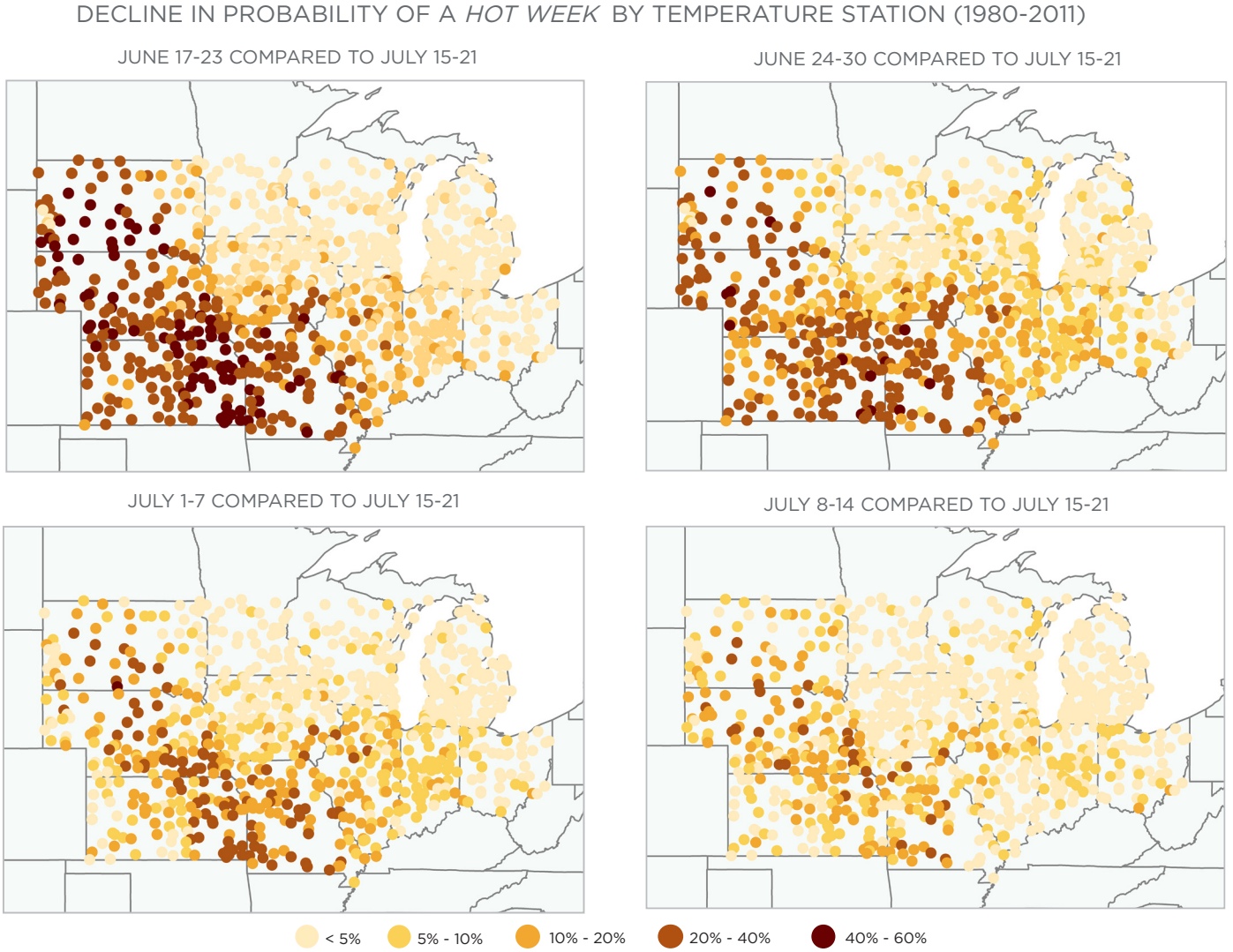

Figure 3: Decline in Probability of a Hot Week by Temperature Station (1980-2011)

[7] http://cropwatch.unl.edu/web/cropwatch/archive?articleID=4613456
[8] http://ohioline.osu.edu/b472/0005.html
[9] http://cropwatch.unl.edu/web/cropwatch/archive?articleID=4613456
[10] http://www.extension.iastate.edu/CropNews/2011/0715elmoretaylor.htm

For each of the four weeks from June 17th to July 14th we then compared the percentage of years each location experienced a Hot Week to the percentage of years that the location experienced a Hot Week during the week of July 15-21. This analysis allowed us to quantify the temperature benefit that a grower in each region could expect to receive if his corn crop pollinates in any of the four weeks from June 17th to July 14th as opposed to the week of July 15-21. This data is summarized in the four graphics seen in Figure 3.

Our analysis showed that the temperature-based benefit to planting early has historically been negligible for most locations in Minnesota, Wisconsin, Michigan, Northern Iowa and Ohio. In the graphics above, any locations with a light yellow dot have historically seen less than a 5% decline in the probability of a Hot Week for that week versus the week of July 15-21. Growers in locations with light yellow dots on the June 17-23 map should carefully consider the germination and freeze risks associated with early planting before attempting an early planting because the historical data shows that these locations have historically received very little relevant temperature benefit from an early planting. Even when growers in those regions plant corn early enough that it pollinates four weeks ahead of the worst pollination week (July 15-21) they see a significant temperature benefit in less than one out of twenty years. There may be other factors which come into play in a grower's decision to plant early, such as if the grower is planting a longer season hybrid, if the region is at higher risk of dry conditions later in the summer that could influence yields, if the grower has a large number of acres that operationally require an early start or, if the grower has sold new crop corn for September or October delivery that will require an earlier harvest. But absent any of these situations or any other benefit that the grower expects to receive from an early planting, an early planting should be discouraged in these regions because the cost and yield risks will usually outweigh the potential yield benefit from temperature alone.

In contrast to the growers in the northern and eastern Corn Belt who have historically seen little temperature benefit as a result of an early planting, the historical data shows that most growers in Kansas, Nebraska, Missouri and western South Dakota have historically experienced a significant temperature benefit from an early planting. In these locations a corn crop that pollinates in the week of June 17-23 is much less likely to experience a Hot Week than a corn crop that pollinates during the week of July 15-21 (up to 56% less likely in the most extreme locations). And in these same regions the benefit of early planting can remain significant even if the corn crop pollinates just one week earlier than the week of July 15-21. Numerous locations in these regions see their risk of encountering a Hot Week during pollination decrease by 20-40% just by pollinating one week earlier, during the week of July 8-14. State-level averages can be seen in Figure 4.[11]

Getting seed planted is the first step in producing a corn crop, but the date of planting will have a critical impact on the yield that the crop makes at the end of the year. And while an early or late planting does not by itself guarantee a good or bad yield, an analysis of historical weather patterns can inform the decision making around what risks and benefits a grower can expect to see when planting earlier or later in a given region.

STATE LEVEL AVERAGE DECLINE IN PROBABILITY OF A HOT WEEK AS COMPARED TO WEEK JULY 15-21

State	June 17-23	June 24-30	July 1-7	July 8-14
Illinois	12 %	12 %	10 %	3 %
Indiana	8 %	9 %	8 %	3 %
Iowa	9 %	7 %	4 %	0 %
Kansas	35 %	25 %	14 %	7 %
Michigan	0 %	2 %	0 %	- 1 %
Minnesota	1 %	2 %	- 3 %	- 2 %
Missouri	32 %	26 %	20 %	9 %
Nebraska	33 %	21 %	15 %	13 %
Ohio	3 %	6 %	2 %	3 %
South Dakota	26 %	17 %	10 %	8 %
Wisconsin	1 %	4 %	1 %	0 %

Figure 4 State level average decline in probability of a Hot Week as compared to week July 15-21.

[11] For the detailed information: www.climate.com/2012outlook/corn-pollination-heat-risk-appendix