farmdoc DAILY

Department of Agricultural and Consumer Economics, University of Illinois Urbana-Champaign

Forming Expectations for 2016 U.S. Average Corn and Soybean Yields: What about El Niño Transitions?

Scott Irwin and Darrel Good

Department of Agricultural and Consumer Economics
University of Illinois

March 16, 2016

***farmdoc daily* (6):51**

Recommended citation format: Irwin, S., and D. Good. "Forming Expectations for 2016 U.S. Average Corn and Soybean Yields: What about El Niño Transitions?" *farmdoc daily* (6):51, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, March 16, 2016.

Permalink: http://farmdocdaily.illinois.edu/2016/03/forming-expectations-for-2016-el-nino-transitions.html

In the *farmdoc daily* articles of March 2, 2016 and March 9, 2016, we examined the historical pattern of U.S. average corn and soybean yields in years since 1960 following a strong El Niño episode that peaked in the period September-March prior to the growing season. There have been a total of twelve such episodes. The purpose of that analysis was to determine if yield expectations for 2016 should be altered based on the current strong El Niño episode that peaked in December 2015. We concluded that:

1) Corn and soybean yields were below trend a little more often in years following the peak of a strong El Niño than the average for all years from 1960 to 2015.

2) The frequency of yields being well below trend was greater following the peak of a strong El Niño episode than the average for all years from 1960 to 2015.

3) The average yields in years following a strong El Niño were below trend regardless of how the years were grouped by strength of the El Niño episode. The average corn yield deviation was slightly larger for stronger El Niño episodes.

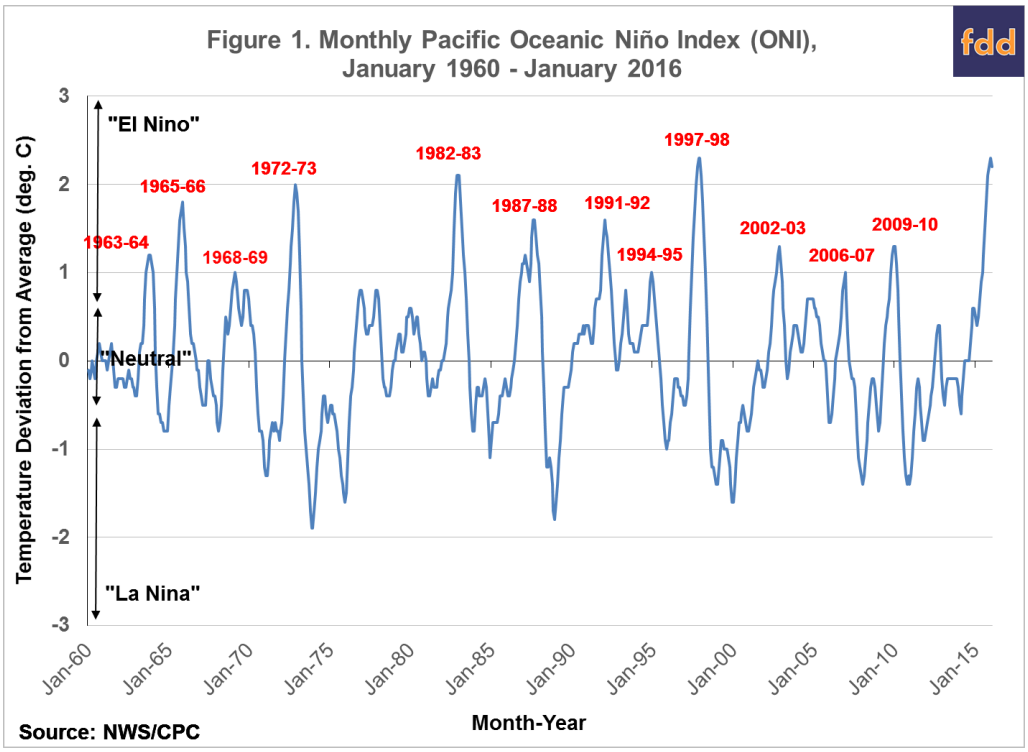
4) For the three strongest El Niño episodes, average corn yields exceeded trend in two years by an average of 4.2 bushels and was below trend by 23 bushels in one year.

5) For the three strongest El Niño episodes, average soybean yields exceeded trend in two years by an average of 0.85 bushels and was below trend by 5.3 bushels in one year.

Overall, we concluded that there is likely an elevated risk of the U.S. average corn and soybean yields falling below trend in 2016. However, we did not consider historical yield performance based on the timing of the transition from an El Niño episode to either neutral conditions or to a La Niña episode. Since some observers appear to believe that the nature of the transition may have weather and yield implications (e.g., Almeida and McFerron, 2015), we expand our previous analysis to consider corn and soybean yield performance in years with different transition patterns from El Niño to either a neutral condition or to a La Niña.

Analysis

We begin by briefly reviewing what constitutes an El Niño episode. In our previous articles (*farmdoc daily*, March 2, 2016; March 9, 2016), we focused on definitions that center on sea surface temperatures in the eastern and central Pacific Ocean area. The most popular definition, then, is for El Niño episodes to occur when the Oceanic Niño Index (ONI-three month centered running mean) in that central and eastern Pacific region (Niño 3.4 region) reaches 0.5 degrees Celsius above average. The strength of the El Niño is measured by the magnitude of the deviation in the three-month mean temperature from the average temperature, where average temperature is based on centered 30-year base periods updated every five years. La Niña episodes occur when the Oceanic Niño Index in Niño 3.4 region is 0.5 degrees Celsius below average, and neutral conditions occur when the Oceanic Niño Index is less than 0.5 degrees Celsius above average or greater than 0.5 degrees below average. An accessible discussion of the definitions can be found in L'Heureux (2014). Figure 1 shows the official ONI data from January 1960 through January 2016. The current El Niño episode is considered one of the strongest episodes since 1960, with the three-month mean temperature exceeding the average temperature by 2.2 degrees Celsius in the three months ending February 2016. Figure 1 also identifies the twelve previous strong El Niño episodes since 1960 that were included in our previous analysis.



The data in Figure 1 indicate there is a regular cyclic pattern to all strong El Niño episodes and they all eventually transition to either neutral or La Niña conditions. The timing and pattern of those transitions, however, has been highly variable. Figure 2 provides further perspective about the variability of that transition. For the previous twelve El Niño episodes, Figure 2 shows the range and average Oceanic Niño Index (ONI) in the months preceding the peak of the El Niño episode and in the months following that peak (the transition period). While there is indeed a highly regular cyclic pattern to El Niño episodes, there has also been a large temperature range in each month preceding and each month following the peak of the episodes. That is, the timing of the transition and the nature of the transition (neutral or La Niña) have varied considerably. Figure 2 also shows the available monthly data on the current El Niño episode. As indicted, the current episode is among the strongest experienced since 1960, with a peak occurring in December 2015, and the January 2016 reading the highest ever for an El Niño episode at this stage.

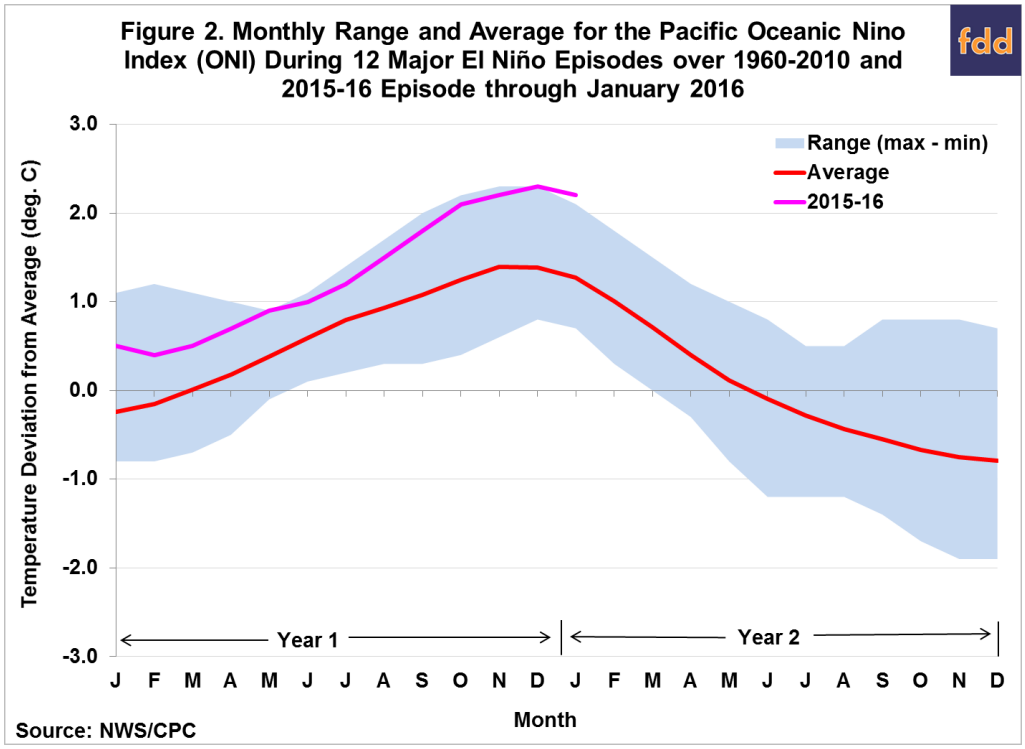
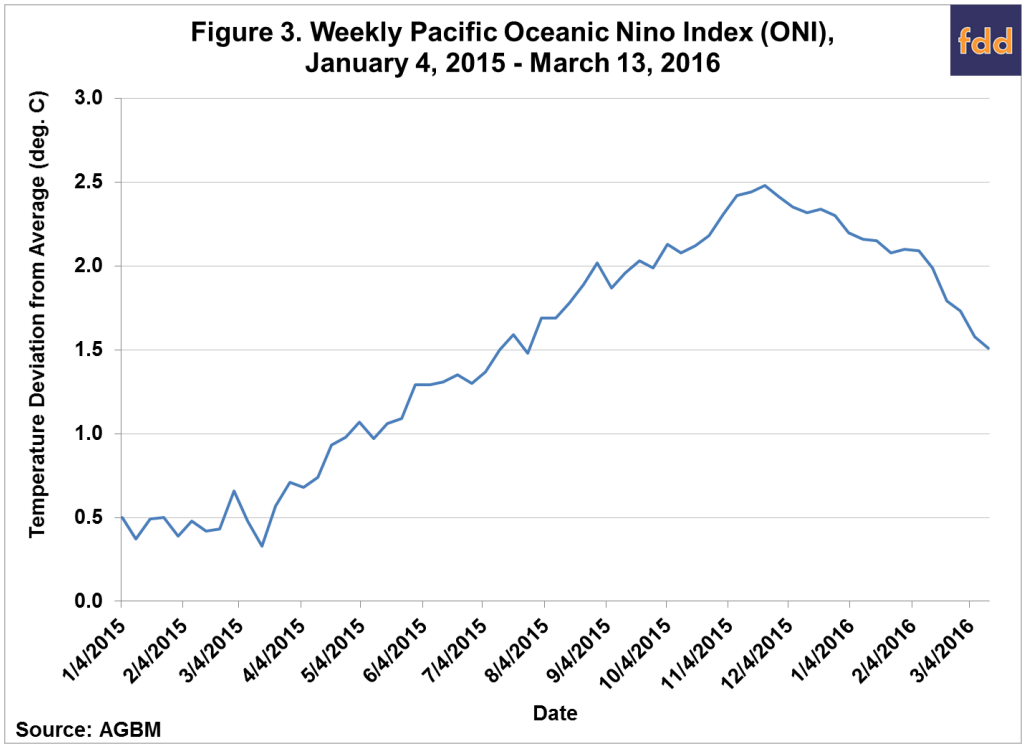


Figure 3 provides a more detailed look at the current El Niño episode based on weekly temperature observations. This more up-to-date data indicates the current episode is fading, consistent with the historical cyclical pattern, but, nonetheless, remained in a strong El Niño status into mid-March. If the decline continues at the average weekly rate of the last month, 0.12 degrees Celsius, it would take another 9 weeks (mid-May) to reach neutral conditions and another 17 weeks (mid-July) to reach La Niña conditions. The historical record suggests the actual pattern of decline could be much slower or faster.



To determine if yield expectations are influenced by the nature of the transition of the El Niño episode, we parse the historical observations according to the status of the episode (remaining in El Niño, neutral conditions, or La Niña conditions) for the four months of the summer growing season—June, July, August,

and September—in the second year of the episode. Those observations are summarized in Appendix Tables 1 through 4, with each table associated with the status of the episode by June, July, August, and September in the second year of the pair of years for each of the strong El Niño episodes. For each of those ending months, the data in the tables include: the twelve years of the El Niño episodes divided according to ending status, the strength of the El Niño (peak temperature anomaly), the month of the peak anomaly, the magnitude of the anomaly in the ending month, the crop year, and both the corn and soybean yield deviation from trend in that crop year. We do not further divide the observations by strength of the El Niño episode, but consider all strong episodes with a peak temperature anomaly of at least 1 degree Celsius, the same as in our previous analysis. Finally, it is important to remember that we start with a total of only twelve observations, so parsing the data as we do by transition status will result in a small number of years in one or more of the transition categories. This suggests treating the resulting estimates of yield performance in each category with some degree of caution.

Not surprisingly, the yield observations paint a bit of a mixed picture of the relationship between the transition status of the El Niño episode and yield performance. Those results are summarized in Table 1. Note that the observations were identical for August and September so results for September are not summarized in Table 1. The following observations can be made based on this summary of results:

1) It has been rare for El Niño conditions to exist beyond June. When a major El Niño episode does persist into June, average corn and soybean yields were above trend in two of the three years. Average yield was well above average for both corn and soybeans in the unusual (single year) cases where the El Niño episode persisted into July or August.

2) Neutral conditions existed in June and July in half the years (6) after major El Niño episodes and corn and soybean yields were below trend in one-third of those years. Neutral conditions existed in August in a third of the years (4) and corn yields were below trend in only one year, but soybean yields were below trend in half the years by an average of 2.5 bushels.

3) La Niña conditions existed in June in one-fourth of the years (3) after major El Niño episodes and both corn and soybean yields were below trend in two of those three years, by an average of 9.9 and 2.4 bushels, respectively. La Niña conditions existed in July in 42 percent of the years (5) and corn yields were below trend in three of those years by an average of 5.5 bushels. Soybean yields were below trend in two of those years by an average of one bushel. La Niña conditions existed in August in 58 percent of the years (7) and corn yields were below trend in four of those years, by an average of 5.3 bushels. Soybean yields were below trend in three of those years by an average of 0.8 bushel.

Table 1. Major El Niño Episodes During the Preseason Period (September-March), Transition Status by Summer of the Second Year, and U.S. Trend Yield Deviations for Corn and Soybeans, 1960-2015

Crop/	By June			By July			By August		
Transition	Total # of Years	# of Years Below Trend	Average Trend Yield Deviation (bu./ac.)	Total # of Years	# of Years Below Trend	Average Trend Yield Deviation (bu./ac.)	Total # of Years	# of Years Below Trend	Average Trend Yield Deviation (bu./ac.)
Corn:									
Continued as El Niño	3	1	-1.5	1	0	11.0	1	0	7.4
Transition to Neutral	6	2	-0.9	6	2	-3.9	4	1	-2.5
Transition to La Niña	3	2	-9.9	5	3	-5.5	7	4	-5.3
Soybeans:									
Continued as El Niño	3	1	-0.4	1	0	2.4	1	0	1.6
Transition to Neutral	6	2	-0.6	6	3	-1.6	4	2	-2.0
Transition to La Niña	3	2	-2.4	5	2	-1.0	7	3	-0.8

Note: The percentage of years below trend is computed based on the number of years in a particular transition category.

Based on these observations, we can now consider whether the transition from a strong El Niño episode to either neutral conditions or to a La Niña episode has a notable impact on corn and soybean yield performance. In our previous article on corn (*farmdoc daily*, March 2, 2016), we found that average yield was below trend 42 percent of the time following a strong El Niño episode (five years out of twelve), compared to the 1960-2015 unconditional average of 39 percent, and by an average of 3.3 bushels. In our previous article on soybeans, (*farmdoc daily*, March 9, 2016), we found that average yield was below trend 42 percent of the time following a strong El Niño episode (five years out of twelve), compared to the 1960-2015 unconditional average of 39 percent, and by an average of 1.0 bushels. The summary in Table 1 indicates that the transition from a strong El Niño episode to neutral conditions portends slightly less risk of below-trend corn and slightly more risk of below-trend soybean yields. Averaged across the three summer months, we find that the corn (soybean) yield was below trend 30 (44) percent of the time by an average of 2.5 (1.4) bushels following transitions to neutral conditions. There is compelling evidence that the transition from a strong El Niño episode to La Niña conditions elevates the risk of below-trend corn and soybean yields. Averaging again across the three summer months, we find that the corn (soybean) yield was below trend 61 (50) percent of the time by an average of 6.9 (1.4) bushels. The results for June show that the earlier the transition to La Niña conditions the greater the risk of below-trend yields.

Implications

Our analysis paints a mixed picture of the relationship between the transition status of major El Niño episodes and corn and soybean yield performance. The transition from a strong El Niño episode to neutral conditions portends slightly less risk of below-trend corn yields and slightly more risk for soybean yields. History suggests that a transition to La Niña by June, July, or August may measurably raise the risk of corn and soybean yields falling below trend. From 1960 through 2015, average corn and soybean yields were below trend 39 percent of the time. La Niña conditions following a strong El Niño have resulted in yields below trend from 40 to 67 percent of the time in the past, depending on the month that La Niña conditions formed. Yield risk was generally larger the earlier that La Niña conditions emerged. The nature of the transition of the current strong El Niño episode is still to be determined. The current episode remains strong, but has substantially weakened in the past month. At the current pace of transition, neutral conditions could exist as early as June and La Niña as early as July. This bolsters our previous conclusion that downside yield risks for corn and soybeans in 2016 are elevated because of the strong ongoing El Niño episode. It also suggests one should keep a close eye on whether a transition to La Niña occurs by summer.

References

Almeida, I., and W. McFerron. “Forget El Nino. La Nina May Turn Grain Markets Upside Down.” *Bloomberg Business*, updated November 13, 2015, accessed March 16, 2016. http://www.bloomberg.com/news/articles/2016-03-16/fed-scales-back-rate-rise-forecasts-as-global-outlook-weakens

Australian Government Bureau of Meteorology. “ENSO Weekly Temperature Observations.” Last updated March 7, 2015, accessed March 16, 2016. http://www.bom.gov.au/climate/enso/nino_3.4.txt

Irwin, S., and D. Good. "Forming Expectations for the 2016 U.S. Average Soybean Yield: What About El Niño?" *farmdoc daily* (6):46, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, March 9, 2016.

Irwin, S., and D. Good. "Forming Expectations for the 2016 U.S. Average Corn Yield: What About El Niño?" *farmdoc daily* (6):41, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, March 2, 2016.

L'Heureux, Michelle. "What is the El Niño-Southern Oscillation (ENSO) in a Nutshell?" *Climate.gov,* posted May 5, 2014, accessed March 9, 2016.https://www.climate.gov/news-features/blogs/enso/what-el-ni%C3%B1o%E2%80%93southern-oscillation-enso-nutshell

NOAA/National Weather Service. "Cold & Warm Episodes by Season." Page last modified November 4, 2015, accessed March 16, 2016. http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

Table A1. Major El Niño Episodes During the Preseason Period (September-March), Transition Status by June of the Second Year, and U.S. Trend Yield Deviations for Corn and Soybeans, 1960-2015

Episode	Peak Temperature Anomaly (deg. C)	Month of Peak	June Temperature Anomaly (deg. C)	Crop Year	Corn Yield Deviation from Trend (bu./ac.)	Soybean Yield Deviation from Trend (bu./ac.)
Continued as El Niño:						
1991-92	1.6	Jan-92	0.8	1992	11.0	2.4
1982-83	2.1	Jan-83	0.7	1983	-23.0	-5.3
1968-69	1.0	Feb-69	0.5	1969	7.4	1.6
Transition to Neutral:						
1965-66	1.8	Nov-65	0.2	1966	0.0	0.8
1994-95	1.0	Dec-94	0.0	1995	-12.4	-1.1
1997-98	2.3	Dec-97	-0.1	1998	3.0	1.3
2002-03	1.3	Nov-02	-0.1	2003	1.7	-5.8
2006-07	1.0	Dec-06	-0.2	2007	2.9	0.4
2009-10	1.3	Jan-10	-0.4	2010	-0.7	0.9
Transition to La Niña:						
1963-64	1.2	Nov-63	-0.6	1964	-6.5	-0.9
1972-73	2.0	Nov-72	-0.8	1973	5.5	0.4
1987-88	1.6	Sep-87	-1.2	1988	-28.6	-6.6
Average Trend Deviation:						
All Years					-3.3	-1.0
Continued as El Niño (3 yrs.)					-1.5	-0.4
Transition to Neutral (6 yrs.)					-0.9	-0.6
Transition to La Niña (3 yrs.)					-9.9	-2.4
2015-16	2.3	Dec-15	?	2016	?	?

Note: Peak temperature anomaly is reported as deviation from average temperature.

Table A2. Major El Niño Episodes During the Preseason Period (September-March), Transition Status by July of the Second Year, and U.S. Trend Yield Deviations for Corn and Soybeans, 1960-2015

Episode	Peak Temperature Anomaly (deg. C)	Month of Peak	July Temperature Anomaly (deg. C)	Crop Year	Corn Yield Deviation from Trend (bu./ac.)	Soybean Yield Deviation from Trend (bu./ac.)
Continued as El Niño:						
1991-92	1.6	Jan-92	0.5	1992	11.0	2.4
Transition to Neutral:						
1968-69	1.0	Feb-69	0.4	1969	7.4	1.6
1982-83	2.1	Jan-83	0.3	1983	-23.0	-5.3
1965-66	1.8	Nov-65	0.2	1966	0.0	0.8
2002-03	1.3	Nov-02	0.1	2003	1.7	-5.8
1994-95	1.0	Dec-94	-0.2	1995	-12.4	-1.1
2006-07	1.0	Dec-06	-0.3	2007	2.9	0.4
Transition to La Niña:						
1963-64	1.2	Nov-63	-0.7	1964	-6.5	-0.9
1997-98	2.3	Dec-97	-0.7	1998	3.0	1.3
2009-10	1.3	Jan-10	-0.8	2010	-0.7	0.9
1972-73	2.0	Nov-72	-1.0	1973	5.5	0.4
1987-88	1.6	Sep-87	-1.2	1988	-28.6	-6.6
Average Trend Deviation:						
All Years					-3.3	-1.0
Continued as El Niño (1 yr.)					11.0	2.4
Transition to Neutral (6 yrs.)					-3.9	-1.6
Transition to La Niña (5 yrs.)					-5.5	-1.0
2015-16	2.3	Dec-15	?	2016	?	?

Note: Peak temperature anomaly is reported as deviation from average temperature.

Table A3. Major El Niño Episodes During the Preseason Period (September-March), Transition Status by August of the Second Year, and U.S. Trend Yield Deviations for Corn and Soybeans, 1960-2015

Episode	Peak Temperature Anomaly (deg. C)	Month of Peak	August Temperature Anomaly (deg. C)	Crop Year	Corn Yield Deviation from Trend (bu./ac.)	Soybean Yield Deviation from Trend (bu./ac.)
Continued as El Niño:						
1968-69	1.0	Feb-69	0.5	1969	7.4	1.6
Transition to Neutral:						
1991-92	1.6	Jan-92	0.2	1992	11.0	2.4
2002-03	1.3	Nov-02	0.2	2003	1.7	-5.8
1965-66	1.8	Nov-65	0.1	1966	0.0	0.8
1982-83	2.1	Jan-83	0.0	1983	-23.0	-5.3
Transition to La Niña:						
1994-95	1.0	Dec-94	-0.5	1995	-12.4	-1.1
2006-07	1.0	Dec-06	-0.6	2007	2.9	0.4
1963-64	1.2	Nov-63	-0.7	1964	-6.5	-0.9
1997-98	2.3	Dec-97	-1.0	1998	3.0	1.3
1987-88	1.6	Sep-87	-1.1	1988	-28.6	-6.6
2009-10	1.3	Jan-10	-1.1	2010	-0.7	0.9
1972-73	2.0	Nov-72	-1.2	1973	5.5	0.4
Average Trend Deviation:						
All Years					-3.3	-1.0
Continued as El Niño (1 yr.)					7.4	1.6
Transition to Neutral (4 yrs.)					-2.5	-2.0
Transition to La Niña (7 yrs.)					-5.3	-0.8
2015-16	2.3	Dec-15	?	2016	?	?

Note: Peak and August temperature anomalies are reported as deviation from average temperature.

Table A4. Major El Niño Episodes During the Preseason Period (September-March), Transition Status by September of the Second Year, and U.S. Trend Yield Deviations for Corn and Soybeans, 1960-2015

Episode	Peak Temperature Anomaly (deg. C)	Month of Peak	September Temperature Anomaly (deg. C)	Crop Year	Corn Yield Deviation from Trend (bu./ac.)	Soybean Yield Deviation from Trend (bu./ac.)
Continued as El Niño:						
1968-69	1.0	Feb-69	0.8	1969	7.4	1.6
Transition to Neutral:						
2002-03	1.3	Nov-02	0.3	2003	1.7	-5.8
1965-66	1.8	Nov-65	0.0	1966	0.0	0.8
1991-92	1.6	Jan-92	0.0	1992	11.0	2.4
1982-83	2.1	Jan-83	-0.3	1983	-23.0	-5.3
Transition to La Niña:						
1994-95	1.0	Dec-94	-0.7	1995	-12.4	-1.1
1963-64	1.2	Nov-63	-0.8	1964	-6.5	-0.9
2006-07	1.0	Dec-06	-0.8	2007	2.9	0.4
1987-88	1.6	Sep-87	-1.2	1988	-28.6	-6.6
1997-98	2.3	Dec-97	-1.2	1998	3.0	1.3
2009-10	1.3	Jan-10	-1.3	2010	-0.7	0.9
1972-73	2.0	Nov-72	-1.4	1973	5.5	0.4
Average Trend Deviation:						
All Years					-3.3	-1.0
Continued as El Niño (1 yr.)					7.4	1.6
Transition to Neutral (4 yrs.)					-2.5	-2.0
Transition to La Niña (7 yrs.)					-5.3	-0.8
2015-16	2.3	Dec-15	?	2016	?	?

Note: Peak temperature anomaly is reported as deviation from average temperature.