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Forming Expectations for the 2017 Brazil and Argentina Corn and Soybean Yields: The Impact of La Niña

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There continues to be considerable discussion about the likely magnitude of South American corn and soybean production in 2017, with much of current focus on weather developments influencing yield prospects. Current USDA forecasts for Brazil place corn and soybean production at 3.41 and 3.82 billion bushels, respectively. Argentine corn and soybean production projections currently sit at 1.44 and 2.04 billion bushels, respectively. This paper is the final entry in our series on South American corn and soybean yield trend and deviation analysis. The development of a La Niña episode in the latter half of 2016 created a significant amount of discussion on the possible yield impacts for both crops in Brazil and Argentina. This article evaluates the possible impact on yield potential in both countries using the trend and deviation analysis developed in the previous reports of the series (*farmdoc daily*, November 2, 2016; November 9, 2016; November 16, 2016; December 14, 2016; December 15, 2016; January 12, 2017; and January 26, 2017).

Factors determining yield for corn and soybeans in South America will unfold over the next several months. For the time being, yield expectations are generally based on trend yield analysis. This raises the perennial issue of what, if anything, can be learned from the historical trends and patterns of average crop yields. In addition, there is the question of whether the trend yield should be altered by information that would influence weather during the upcoming growing season. This year, for example, there is particular interest in whether the current La Niña episode should influence expectations about 2017 growing season weather and any resulting deviation from trend yield. We begin by reviewing corn and soybean yields in previous years of La Niña episodes to determine if the expectation of trend yield should be altered due to the current La Niña episode.

Historical Yields and Patterns Synopsis

We provide detailed analysis of historic corn and soybean yields in the previous set of articles. We briefly summarize the analysis here as a starting point for forming yield expectations for 2017. The national yield data for Brazil revealed two important patterns. First, corn yields have increased exponentially over time rather than in a linear fashion, as is the case for the U.S., and second, yields increased at a faster rate beginning in the late 1980s. We thought that these two patterns, particularly the faster rate of yield increase beginning in the late 1980s might be associated with expansion of corn production into the second season, or Safrinha, areas. When we examined trend yields for first and second corn crops separately, we found that yields since 1989 have increased more rapidly for the second crop than for the

first crop. As a result, there is value in considering the two crops independently when forming national production expectations. Positive yield deviations from trend corn yields have occurred more frequently than negative deviations in both the first and second season corn crops in Brazil and negative deviations have tended to be larger than positive deviations. Deviations were larger for the second crop than for the first crop. Corn yields in Argentina have also increased in an exponential fashion and yield deviations from trend for corn have been very symmetric. That is, yields have been above and below trend in equal proportions. Average as well as maximum positive and negative deviations have been very similar in magnitude.

For soybeans, the rapid expansion of production into the Central West region of Brazil motivated us to examine whether or not yield patterns have differed in that region compared to the rest of the country. Trend yield patterns were similar to the rest of the country in that region, but deviations from trend were not as large in the Central West region. Soybean yields have increased in a linear fashion for both countries since 1978. For Argentina, yields have been above trend more often than below trend. Both average and maximum negative yield deviations have been larger than positive deviations. In contrast, positive and negative yield deviations for Brazilian soybeans have been much more symmetric in both frequency and magnitude. For this analysis, we use national crop yield data from USDA FAS in assessing possible La Niña impacts on trend yield deviations.

The La Niña Impact

There is considerable discussion about the potential impact of the current La Niña episode on South American growing season weather and the resulting effect on crop yields. The question is: Should the potential for trend yield deviations be adjusted due to this episode? We start with a brief discussion of what constitutes an El Niño/ La Niña episode and then examine the historical record of corn and soybean yields in both countries in years with events similar to the current one.

As defined by the National Oceanic and Atmospheric Administration (NOAA), "El Niño and La Niña are opposite phases of a natural climate pattern across the tropical Pacific Ocean that swings back and forth every 3-7 years on average. Together, they are called ENSO, which is short for El Niño-Southern Oscillation. The ENSO pattern in the tropical Pacific can be in one of three states: El Niño, Neutral, or La Niña. El Niño (the warm phase) and La Niña (the cool phase) lead to significant differences from average ocean temperatures, winds, surface pressure, and rainfall across parts of the tropical Pacific. Neutral indicates that conditions are near their long-term average." The definition encompasses four weather factors (temperature, wind, rainfall and surface pressure) and a rather vague description of the geographical location of these factors. The definitions are further refined by L'Heureux (2014) as:

> *El Niño: A warming of the ocean surface, or above-average sea surface temperatures (SST), in the central and eastern tropical Pacific Ocean. Over Indonesia, rainfall tends to become reduced while rainfall increases over the tropical Pacific Ocean. The low-level surface winds, which normally blow from east to west along the equator ("easterly winds"), instead weaken or, in some cases, start blowing the other direction (from west to east or "westerly winds").*
>
> *La Niña: A cooling of the ocean surface, or below-average sea surface temperatures (SST), in the central and eastern tropical Pacific Ocean. Over Indonesia, rainfall tends to increase while rainfall decreases over the central tropical Pacific Ocean. The normal easterly winds along the equator become even stronger.*
>
> *Neutral: Neither El Niño or La Niña. Often tropical Pacific SSTs are generally close to average*

These definitions center on sea surface temperatures in the eastern and central Pacific Ocean and are the popular way to describe the ENSO episodes. For our purposes, then, La Niña episodes occur when the Oceanic Niño Index (ONI-three month running mean) in that central and eastern Pacific region (Niño 3.4 region) reaches -0.5C below average. The strength of the La Niña is measured by the magnitude of the deviation in the three-month running mean temperature from the average temperature, where average temperature is based on centered 30-year base periods updated every five years. The official ONI data from January 1960 through December 2016 provides measures of the temperature deviations and indicates the occurrence of a La Niña episode at the end of 2016.

Since our interest is in La Niña episodes preceding the South American growing season, we specifically consider episodes that occur in the portion of the pre-plant period extending from July to December of the calendar year previous to the year of harvest, regardless of how and when the episode eventually

transitioned. (For earlier analysis of possible El Niño impacts on U.S. corn, soybean, and wheat yields, see the *farmdoc daily* articles of February 26, 2015; March 19, 2015; March 26, 2015; and April 23, 2015). We define a La Niña episode as those in which the actual three-month running mean temperature fell below the long run average temperature by at least 0.5C. The nine La Niña episodes that meet these two criteria are labeled in Figure 1. The two previous episodes that most closely resemble the current episode in terms of magnitude occurred in 2000 and 2011 which impacted the 2001 and 2012 crop yields. Readers should note that other measures of La Niña episodes may have relevance that we have not considered, and these other measures may result in a different set of analog years to 2017.

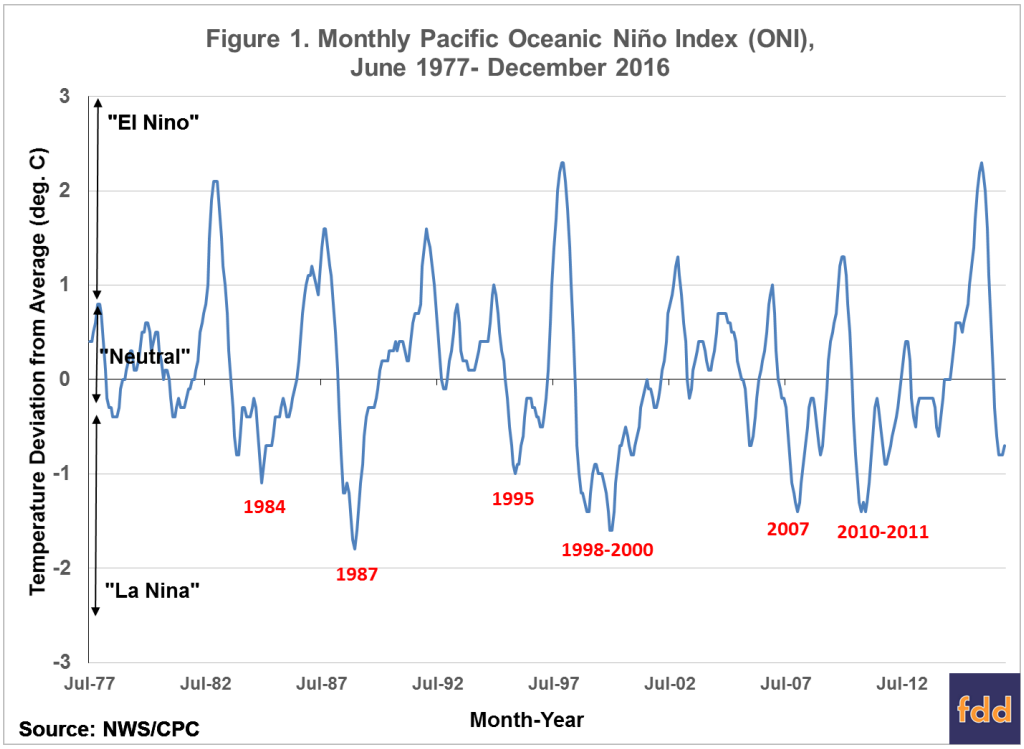

Table 1 presents more detail on the conditions during each of the nine previous La Niña episodes that meet our definition, and the trend deviation for the average corn and soybean yield in the following year for each country. Specifically, for each of those episodes, we show the peak temperature anomaly, the month of the peak anomaly, the crop year following the peak anomaly, and the yield deviation from trend in those crop years.

Table 1. La Niña Episodes During the Preseason Period (July-December) and Trend Yield Deviations for Corn and Soybeans in Brazil and Argentina, 1978-2016

				Brazil		Argentina	
Episode	Peak Temperature Anomaly (deg. C)	Month of Peak	Crop Year	Corn Yield Deviation from Trend (bu./ac.)	Soybean Yield Deviation from Trend (bu./ac.)	Corn Yield Deviation from Trend (bu./ac.)	Soybean Yield Deviation from Trend (bu./ac.)
La Niña Episodes:							
1984	-1.1	Dec-84	1985	0.7	1.1	2.4	-0.8
1987	-1.8	Dec-88	1988	1.4	-2.2	0.8	2.5
1995	-1.0	Nov-95	1996	-1.6	-0.1	-9.2	-4.1
1998	-1.4	Dec-98	1999	-1.1	1.2	4.1	0.3
1999	-1.6	Dec-99	2000	-5.2	2.3	4.6	0.2
2000	-0.8	Dec-00	2001	3.9	5.8	0.6	2.9
2007	-1.3	Dec-07	2008	2.7	1.7	-2.8	2.7
2010	-1.4	Dec-10	2011	-1.7	3.4	-8.8	-0.4
2011	-0.9	Dec-11	2012	5.9	-3.9	-25.6	-6.6
Average Trend Deviation:				0.6	1.0	-3.8	-0.4
2016	-0.8	Nov-16	2017	?	?	?	?

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

The pattern of average corn and soybean yields in years following a La Niña episode provides limited information for 2017 yield expectations in both Brazil and Argentina.

For Brazil:

1) The average corn yield in those nine years was 0.6 bushels above trend. The average soybean yield was 1.0 bushels above trend.

2) The deviation from trend for corn ranged from -5.2 bushels to 5.9 bushels. The deviation from trend for soybeans ranged from -3.9 bushels to 5.8 bushels.

3) The average corn yield was below trend 44 percent of the time (four years), compared to the unconditional average of 41 percent. The average soybean yield was below trend 22 percent of the time (two years), compared to the unconditional average of 49 percent.

4) Of the 11 years since 1978 that the soybean average yield in Brazil was at least two bushels below trend, two followed a La Niña episode. Of the 10 years since 1978 that the Brazilian corn average yield was at least two bushels below trend, one followed a La Niña episode.

5) Of the 10 years since 1978, soybean average yield in Brazil was at least two bushels above trend, three followed a La Niña episode. Of the 13 years since 1978 that the average Brazilian corn yield was at least two bushels above trend, three followed a La Niña episode.

6) Table 2 provides analysis of first and second crop corn yield trend deviations from 1989-2016. La Niña episodes occurred in 7 years during the time span. The average first crop corn yield in those 7 years was 0.5 bushels above trend. The average second crop corn yield was 0.3 bushels above trend. The impact of La Niña episodes on each crop is similar to the national average corn yield findings.

Table 2. La Niña Episodes During the Preseason Period (July-December) and Trend Yield Deviations for First and Second Crop Corn in Brazil , 1989-2016

				Brazil	
Episode	Peak Temperature Anomaly (deg. C)	Month of Peak	Crop Year	First Crop Corn Yield Deviation from Trend (bu./ac.)	Second Crop Corn Yield Deviation from Trend (bu./ac.)
La Niña Episodes:					
1995	-1.0	Nov-95	1996	-1.4	4.7
1998	-1.4	Dec-98	1999	-2.2	0.3
1999	-1.6	Dec-99	2000	-5.6	-13.6
2000	-0.8	Dec-00	2001	5.1	5.2
2007	-1.3	Dec-07	2008	2.7	2.2
2010	-1.4	Dec-10	2011	-1.5	-8.4
2011	-0.9	Dec-11	2012	6.3	11.4
Average Trend Deviation:				0.5	0.3
2016	-0.8	Nov-16	2017	?	?

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

For Argentina:

1) The average corn yield in those nine years was 3.8 bushels below trend. The average soybean yield was .04 bushels below trend.

2) The deviation from trend for corn ranged from -25.6 bushels to 4.6 bushels. The deviation from trend for soybeans ranged from -6.6 bushels to 2.9 bushels.

3) The average corn yield was below trend 44 percent of the time (four years), compared to the unconditional average of 51 percent. The average soybean yield was below trend 44 percent of the time (four years), compared to the unconditional average of 44 percent.

4) Of the 10 years since 1978 that the soybean average yield in Argentina was at least two bushels below trend, three followed a La Niña episode. Of the 16 years since 1978 that the Argentina corn average yield was at least two bushels below trend, two followed a La Niña episode.

5) Of the 13 years since 1978, soybean average yield in Argentina was at least two bushels above trend, three followed a La Niña episode. Of the 13 years since 1978 that the average Argentinian corn yield was at least two bushels above trend, three followed a La Niña episode.

On average, Brazil appears to get a slight bump in yields above trend for both corn and soybeans in La Niña years. Argentina takes a small yield hit in soybean yields, while corn yield deviations are highly influenced by one large negative deviation in 2012. The variance in both countries during La Niña episodes is large and forms no specific pattern. For both countries, a La Niña episode led to positive trend yield deviations in both crops more often than negative deviations.

Implications

With current U.S. and world soybean and corn supplies in surplus, the size of the 2017 South American crops will be very important in determining the direction of crop prices over the next year or more. We find that the history of corn and soybean yields conditioned on a La Niña episode, such as the one currently underway, does not provide a definitive indication of the direction or magnitude of the trend deviation to expect in 2017. In the two previous episodes most closely resembling the current episode in terms of magnitude (2001 and 2012), yield exceeded trend for both crops in each country in 2001, while 2012 saw yields below trend for soybeans in both countries. Corn trend yield deviation in 2012 was positive in Brazil, but Argentina suffered one of its largest negative trend deviations at 25.6 bushels below trend. It is difficult to draw any meaningful implications on 2017 trend deviations from the analysis. Readers should note that other measures of La Niña episodes that we have not considered may have relevance. Our analysis does not negate the possibility of negative deviations from trend but finds no meaningful results for a La Niña episode during the time period under consideration.

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