El Niño: Could This Cyclical Extreme Be Good for Corn and Soybean Production?

Weather forecasters have declared the arrival of El Niño, complex weather patterns resulting from variations in ocean temperatures in the Pacific Ocean. The National Oceanic and Atmospheric Administration (NOAA) says the “forecaster consensus” is for a strong El Niño event that has a 90 percent chance of persisting through fall and an 85 percent chance of lasting through winter. What does this mean for major crops across America’s heartland, namely corn and soybeans? History offers some clues.

Highlights

- **El Niño Conditions Present.** Above-average sea surface temperatures have been recorded this spring and summer in parts of the Pacific Ocean, and are forecasted to persist into 2016. These El Niño conditions can significantly impact U.S. weather patterns, including warmer-than-average temperatures over the western and northern United States, wetter-than-average conditions over portions of the U.S. Gulf Coast and Florida, and drier-than-average conditions in the Ohio Valley and Pacific Northwest.

- **Corn and Soybean Production Mixed.** In the June 30 Acreage report, the USDA National Agricultural Statistics Service estimated total U.S. planted corn acreage at 88.987 million acres, which is a 1.7 million acre decline from 2014 final planted acres and would rank in the upper 25 percent of planted crops since USDA started keeping records in 1926. Planted soybeans were estimated at 85.139 million acres, representing a 1.438 million acre increase compared to final 2014 data and would be the highest on record since USDA started tracking soybean planted acreage in 1960.

- **El Niño Has Impacted Crops in the Past.** The markets are currently pricing new crop corn and soybean futures prices higher due to recent excessive wet weather in the eastern Corn Belt and southern states. However, if predictions of a moderate to strong El Niño through the second half of 2015 and into 2016 are true, then history shows that it’s uncommon to have subpar national crop production results for corn and soybeans except in the few cases where very hot, dry weather occurs during the critical crop development phase in June and July. If predictions are correct, this could signal higher than expected corn and soybean yields this year.
From the Pacific to the Plains: Ocean Temps Affect Weather Patterns

El Niño and La Niña are opposite phases of what is known as the El Niño-Southern Oscillation (ENSO) cycle. This cycle represents temperature fluctuations between the ocean and atmosphere in the east-central Pacific Ocean near the equator.

El Niño is the warm phase of ENSO, while La Niña is the cold phase. These deviations from normal surface temperatures can have large-scale impacts on global weather and climate.

According to NOAA, El Niño and La Niña episodes typically last nine to 12 months, but some prolonged events may last for years. El Niño and La Niña events occur on average every two to seven years, but their frequency can be irregular. El Niño typically occurs more frequently than La Niña.

El Niño

The term El Niño refers to the large-scale, periodic warming in sea surface temperatures across the east-central equatorial Pacific Ocean, and the resulting impact on weather. Typical El Niño effects are likely to be strongest over North America during the winter months, since the ENSO temperature fluctuations usually reach their seasonal peaks during the November through February time period; however, weather impacts can occur at any time of the year. These include warmer-than-average temperatures over western and central Canada, and over the western and northern United States. Wetter-than-average conditions are likely over portions of the U.S. Gulf Coast and Florida, while drier-than-average conditions can be expected in the Ohio Valley and the Pacific Northwest. The presence of El Niño can significantly influence weather patterns, ocean conditions, and marine fisheries across large portions of the globe for an extended period of time.

El Niño means “The Little Boy,” or “Christ Child,” in Spanish. El Niño was originally recognized by fishermen off the coast of South America in the 1600s, with the appearance of unusually warm water in the Pacific Ocean. The name refers to the time of year (around December) during which these warm water events tended to occur.
The Current Forecasts

The current “forecaster consensus” is for a strong El Niño event but doesn’t specify how strong, according to NOAA. Its forecast indicates a 90 percent chance that El Niño will persist through fall and an 80 percent chance it will last through winter.

The Oceanic Nino Index (ONI) is a principal measure used by the U.S. National Weather Service for monitoring, assessing and predicting the ENSO cycle. The ONI is based on sea surface temperature departures from average in a specified area of the Pacific Ocean called the Nino 3.4 Zone. The ONI is a three-month “centered” moving average of the current month’s temperature deviation along with the preceding and following months’ readings. El Niño is characterized by an ONI equal to or greater than 0.5 C. La Niña is characterized by an ONI equal to or less than -0.5 C. By historical standards, to be classified as a full-fledged El Niño or La Niña episode, the ONI must be equal to or exceed these thresholds for at least five consecutive months.

Almost all forecasting models indicate that the ONI will be equal to or greater than 0.5 C through the end of 2015. Several models suggest that the ONI will exceed 1.5 C later in the year—considered a “strong” El Niño reading.
Corn and Soybean Crop Ratings: 2015 Trailing 2014

In a report released June 30, 2015, the USDA-NASS estimated total U.S. planted corn acreage at 88.987 million acres and planted soybean acreage at 85.139 million acres. Compared to the final 2014 planted acres, these estimates would represent a 1.7 million acre decline for corn and a 1.438 million acre increase for soybeans. While the soybean planted acreage estimate would represent an all-time record if realized, the corn estimate would rank at around the 75th percentile all-time (since recording began with the 1926 crop).

Figure 1 shows the crop condition and crop progress for U.S. corn as of July 19. Corn planting benefited from excellent weather conditions during the last week in April through the entire month of May, and proceeded well ahead of schedule. Emergence also proceeded well ahead of schedule across most of the major producing regions.
The overall condition of the U.S. corn crop is above the five-year average but trailing the excellent 2014 crop ratings. The portion of the crop rated good to excellent is at 69 percent, compared to 76 percent for the same period in 2014. Excessive precipitation has been the main culprit for production issues in several states with poor to very poor ratings for 26 percent of the crop in Indiana and 20 percent in Ohio.

Figure 2 shows crop condition and crop progress for U.S. soybeans as of July 19. Unlike corn, progress of the soybean crop started to fall behind the five-year average during the last week of May, as excessive wetness delayed planting in the west-central and southern regions of the Corn Belt. However, considerable progress was made and, as of the final estimate on July 5, approximately 96 percent of the crop had been planted. In the July 19 report, the national crop is on target in terms of development, equaling the five-year average at 56 percent blooming and 17 percent setting pods. The overall U.S. soybean crop condition rating was trailing 2014 by 11 percentage points at 62 percent good to excellent compared to 73 percent last year. Minnesota, which saw one of the largest gains in planted soybean acres in 2015, also has its highest soybean condition rating ever at this time of the year with 79 percent of the crop rated good to excellent and only 2 percent of the crop rated poor to very poor. At the other end of the spectrum, Indiana has 28 percent and Ohio has 23 percent of their crops rated poor to very poor.
**Historical Impact of El Niño on Corn and Soybeans**

**El Niño: What Can History Tell Us About Its Past Impact on Corn, Soybean Production?**

With El Niño conditions expected to be present through the remainder of 2015 and into next year, what is the likely impact on U.S. corn and soybean production? AgriBank analysis of historical records indicates that, with a few exceptions, El Niño is strongly correlated with positive results for both crops.

The consensus opinion is that we are entering into at least a weak El Niño phase in the ENSO cycle, and some forecasters are even calling for this upcoming event to be a strong or very strong El Niño rivaling the events of 1982/83 and 1997/98. From a crop production perspective, only 1983 was a very poor year among those four years. In that year, heavy rains in the spring delayed or prevented planting, and the onset of hot, dry conditions in the summer severely stressed the late-planted crop. It should also be pointed out that 1983 started out with El Niño but transitioned to a La Niña during the latter half of the year – one of the worst-case scenarios for corn and soybean production (1988 was a similar year).

Historical examination of El Niño events and U.S. corn and soybean production indicates that the main negative threat to production is a wet spring followed by a hot summer that damages a susceptible late-developing crop. This is usually the El Niño to La Niña transition scenario like what occurred in 1983 and 1988. Occasionally, a hot, dry spell in June or July during critical crop development stages can also cause subpar production results such as in 1991, 2002, and 1997 (for corn). The Great Flood year of 1993 was an anomaly due to a shift in the “Bermuda High” weather pattern, which cannot be directly correlated to a particular ENSO pattern, as no confirmed El Niño occurred that year.

However, history indicates that, in years where there is a late season onset of El Niño (average ONI values equal to or greater than 0.5 °C for the third and fourth quarters of year), odds are very good for having better than average corn and soybean crops. If there is an analog to the current year so far, it would likely be 1997, which was a record El Niño year. In that year, corn yields came in slightly below trend, while soybean yields were slightly above trend. Acreage abandonment was near average for both crops. Corn saw less planted acreage than intended while soybeans saw more.

Crop producers can prepare for the likely El Niño event by monitoring short- and long-range weather forecasts, adjusting marketing and operations plans as necessary based on the forecasts, and ensuring appropriate risk management tools are in place to protect against extreme weather conditions.
Notable Trends:

- Positive yield deviation in eight out of 11 years (73 percent)
- Lower than average acreage abandonment in seven out of 11 years (64 percent)
- Increased planted acreage (over March intentions) in two out of seven years (29 percent)
- Negative results in 1991 and 2002 due to wet springs with hot, dry summers and rains coming too late for crop to fully recover
- Negative result in 1997 in Iowa due to very hot, dry spell during July, which caused damage to the crop during the vulnerable silking stage of production

**TABLE:** Corn: Years With El Niño Conditions in Both Q3 and Q4 (Average Quarterly ONI > 0.5 C)

<table>
<thead>
<tr>
<th>Year</th>
<th>Yield Deviation from Trend</th>
<th>Excess Abandon (%)</th>
<th>Final Plant vs Intended</th>
<th>Previous Year Ave ONI</th>
<th>Current Year Ave ONI</th>
<th>Annual Average Ann Ave</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q3</td>
<td>Q4</td>
<td></td>
</tr>
<tr>
<td>1963</td>
<td>+3.0</td>
<td>+0.94</td>
<td>-0.167 -0.333 -0.167 0.267</td>
<td>0.933 1.167</td>
<td>0.550 0.792</td>
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</tr>
<tr>
<td>1965</td>
<td>+5.4</td>
<td>+1.43</td>
<td>-0.733 -0.800 -0.300 0.400</td>
<td>1.300 1.667</td>
<td>0.767 1.133</td>
<td></td>
</tr>
<tr>
<td>1969</td>
<td>+9.6</td>
<td>+0.48</td>
<td>0.400 0.600 0.933 0.600</td>
<td>0.567 0.767</td>
<td>0.717 0.683</td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>+15.0</td>
<td>+0.00</td>
<td>-0.767 -0.833 -0.367 0.567</td>
<td>1.300 1.900</td>
<td>0.850 1.758</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>+12.2</td>
<td>-1.00</td>
<td>-0.267 -0.067 0.100 0.600</td>
<td>1.100 2.033</td>
<td>0.958 1.192</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>+9.3</td>
<td>-0.52</td>
<td>0.433 1.000 1.133 1.000</td>
<td>1.533 1.233</td>
<td>1.25 0.983</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>-9.6</td>
<td>-0.79</td>
<td>0.333 0.367 0.300 0.400</td>
<td>0.700 1.133</td>
<td>0.633 0.358</td>
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</tr>
<tr>
<td>1997</td>
<td>-2.9</td>
<td>-0.10</td>
<td>-0.267 -0.433 -0.367 0.567</td>
<td>1.700 2.267</td>
<td>1.042 1.467</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>-9.8</td>
<td>+3.12</td>
<td>-0.067 -0.267 -0.067 0.433</td>
<td>0.900 1.200</td>
<td>0.617 0.900</td>
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</tr>
<tr>
<td>2004</td>
<td>+17.4</td>
<td>-0.27</td>
<td>0.200 0.400 0.200 0.200</td>
<td>0.633 0.700</td>
<td>0.433 0.150</td>
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<tr>
<td>2009</td>
<td>+12.3</td>
<td>-0.62</td>
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<td>0.600 1.167</td>
<td>0.325 1.000</td>
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<tr>
<td>Average</td>
<td>+5.6</td>
<td>+0.24</td>
<td>-0.103 -0.079 0.070 0.473</td>
<td>1.024 1.385</td>
<td>0.738 0.947</td>
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</table>
Positive yield deviation in nine out of 11 years (82 percent)

Lower than average acreage abandonment in six out of 11 years (55 percent)

Increased planted acreage (over March intentions) in six out of seven years (86 percent)

Negative results in 1991 and 2002 due to wet springs with hot, dry summers and rains coming too late for crop to fully recover

Most gains in planted acreage due to switch from corn to soybeans, which can be planted later in most regions

**El Niño: the three-quarter effect**

Further analysis shows that, in years when El Niño conditions are present for the second, third and fourth quarters, the positive impact on corn and soybean crop production can be even greater than when the conditions are present for only the last half of the year. When final data is available, these conditions will most likely be the case for 2015.
**CORN:**
- Positive yield in four out of five years (80 percent)
- Less abandonment in four out of five years (80 percent)
- More planted acres in zero out of three years (0 percent)

**SOYBEANS:**
- Positive yield in five out of five years (100 percent)
- Less abandonment in two out of five years (40 percent)
- More planted acres in three out of three years (100 percent)

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### TABLE: Corn: Years With El Niño Conditions in Q2-Q4 (Average Quarterly ONI > 0.5 C)

<table>
<thead>
<tr>
<th>Year</th>
<th>Yield Deviation from Trend</th>
<th>Excess Abandon (%)</th>
<th>Final Plant vs Intended</th>
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<tbody>
<tr>
<td>1969</td>
<td>+9.6</td>
<td>+0.48</td>
<td></td>
<td>Q3 0.400 Q4 0.600</td>
<td>Q1 0.933 Q2 0.600 Q3 0.567 Q4 0.767</td>
<td>0.717</td>
<td>0.683</td>
</tr>
<tr>
<td>1972</td>
<td>+15.0</td>
<td>+0.00</td>
<td></td>
<td>Q3 0.767 Q4 0.833</td>
<td>Q1 0.367 Q2 0.567 Q3 1.300 Q4 1.900</td>
<td>0.850</td>
<td>1.758</td>
</tr>
<tr>
<td>1982</td>
<td>+12.2</td>
<td>-1.00</td>
<td>-2.8</td>
<td>Q3 0.267 Q4 0.067</td>
<td>Q1 0.100 Q2 0.600 Q3 1.100 Q4 2.033</td>
<td>0.958</td>
<td>1.192</td>
</tr>
<tr>
<td>1987</td>
<td>+9.3</td>
<td>-0.52</td>
<td>-1.4</td>
<td>Q3 0.433 Q4 1.000</td>
<td>Q1 1.133 Q2 1.000 Q3 1.533 Q4 1.233</td>
<td>1.25</td>
<td>0.983</td>
</tr>
<tr>
<td>1997</td>
<td>-2.9</td>
<td>-0.10</td>
<td>-1.9</td>
<td>Q3 0.267 Q4 0.433</td>
<td>Q1 0.367 Q2 0.567 Q3 1.700 Q4 2.267</td>
<td>1.042</td>
<td>1.467</td>
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<tr>
<td>Average</td>
<td>+8.6</td>
<td>-0.23</td>
<td>-2.0</td>
<td>Q3 -0.093 Q4 0.053</td>
<td>Q1 0.287 Q2 0.667 Q3 1.240 Q4 1.640</td>
<td>0.958</td>
<td>1.217</td>
</tr>
</tbody>
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### TABLE: Soybeans: Years With El Niño Conditions in Q2-Q4 (Average Quarterly ONI > 0.5 C)

<table>
<thead>
<tr>
<th>Year</th>
<th>Yield Deviation from Trend</th>
<th>Excess Abandon (%)</th>
<th>Final Plant vs Intended</th>
<th>Previous Year Ave ONI</th>
<th>Current Year Ave ONI</th>
<th>Annual Average</th>
<th>Change in Ann Ave</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>+1.6</td>
<td>+0.56</td>
<td></td>
<td>Q3 0.400 Q4 0.600</td>
<td>Q1 0.933 Q2 0.600 Q3 0.567 Q4 0.767</td>
<td>0.717</td>
<td>0.683</td>
</tr>
<tr>
<td>1972</td>
<td>+0.8</td>
<td>+0.36</td>
<td></td>
<td>Q3 -0.767 Q4 -0.833</td>
<td>Q1 -0.367 Q2 0.567 Q3 1.300 Q4 1.900</td>
<td>0.850</td>
<td>1.758</td>
</tr>
<tr>
<td>1982</td>
<td>+0.5</td>
<td>+0.17</td>
<td>+1.4</td>
<td>Q3 -0.267 Q4 0.067</td>
<td>Q1 0.100 Q2 0.600 Q3 1.100 Q4 2.033</td>
<td>0.958</td>
<td>1.192</td>
</tr>
<tr>
<td>1987</td>
<td>+0.8</td>
<td>-0.57</td>
<td>+1.3</td>
<td>Q3 0.433 Q4 1.00</td>
<td>Q1 1.133 Q2 1.000 Q3 1.533 Q4 1.233</td>
<td>1.225</td>
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<tr>
<td>1997</td>
<td>+1.8</td>
<td>-0.20</td>
<td>+1.2</td>
<td>Q3 -0.267 Q4 -0.433</td>
<td>Q1 -0.367 Q2 0.567 Q3 1.700 Q4 2.267</td>
<td>1.042</td>
<td>1.467</td>
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<tr>
<td>Average</td>
<td>+1.1</td>
<td>+0.06</td>
<td>+1.3</td>
<td>Q3 -0.093 Q4 0.053</td>
<td>Q1 0.287 Q2 0.667 Q3 1.240 Q4 1.640</td>
<td>0.958</td>
<td>1.217</td>
</tr>
</tbody>
</table>
Methodology for analyzing El Niño trends

The accompanying analysis of the El Niño impact on corn and soybean production took the following approach:

- Looked at three production performance variables (green shading indicates positive result, red shading indicates negative result):  
  - Deviation (+/-) in national average yield per acre from the long-term trend line yield (1948 to 2014 for corn, 1960 to 2014 for soybeans)  
  - The percent of final planted acres not harvested (proxy for “abandoned” acres) minus the Olympic average (drop high and low, then average remaining) of the previous five years  
  - The difference between the final reported planted acres and the acres initially reported in the March USDA Prospective Plantings report (proxy for prevented plant acres and acres switched to other late planted crops)

- Looked at annual data from 1960 through 2014 crops for yield deviation and percent not harvested (due to limitations in data history, the difference in acreage planted analysis only goes back to 1975)

- Classified years according to quarterly average ONI values (green highlights imply meets El Niño criteria, red highlights imply meets La Nina criteria) for the last two quarters of the preceding year and the four quarters of the current year—corn and soybeans are usually planted in the spring (March to May) and harvested in the fall (September to November)

- Expect that, based upon 2015 year-to-date ONI values and the National Weather Service ENSO outlook, the quarterly ONI average values for 2015 will be at or above the El Niño threshold for at least the third and fourth quarters and most likely also for the second quarter of 2015
About AgriBank

AgriBank is one of the largest banks within the national Farm Credit System, with more than $90 billion in total assets. Under the Farm Credit System’s cooperative structure, AgriBank is primarily owned by 17 affiliated Farm Credit Associations. The AgriBank District covers America’s Midwest, a 15-state area stretching from Wyoming to Ohio and Minnesota to Arkansas. About half of the nation’s cropland is located within the AgriBank District, providing the Bank and its Association owners with expertise in production agriculture. For more information, visit www.AgriBank.com.

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