How Should We Use Within-Season Crop Condition Ratings for Corn and Soybeans?

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In the *farmdoc daily* article of May 24, 2017 we examined the relationship between corn and soybean crop condition ratings at various times in the growing season and the U.S. average yield in order to determine when during the season we should pay serious attention to the ratings to form yield expectations. The analysis in that article indicated that: (1) there has been a strong correlation between trend-adjusted U.S. corn and soybean yields since 1986 and the percentage of the crops rated in good or excellent condition at the end of the season; and (2) the correlations between crop conditions and yields are low early in the season and then rise sharply for corn into mid-July and rise more gradually for soybeans into mid-August. Here, we extend that analysis by identifying adjustments that could be made to ratings during the growing season in order to make them more useful in forming expectations about final condition ratings and yield expectations.

Background

We start with a brief description of the condition ratings and the procedure for developing those ratings. Our discussion draws mainly from the procedure for surveying crop condition ratings and making crop condition ratings as described in the May 22, 2017 *Crop Progress* report. For both corn and soybeans, conditions are reported as the percentage of the crop rated to be in one of five categories, described as follows:

- Very Poor - Extreme degree of loss to yield potential, complete or near crop failure. Pastures provide very little or no feed considering the time of year. Supplemental feeding is required to maintain livestock condition.

- Poor - Heavy degree of loss to yield potential which can be caused by excess soil moisture, drought, disease, etc. Pastures are providing only marginal feed for the current time of year. Some supplemental feeding is required to maintain livestock condition.

- Fair - Less than normal crop condition. Yield loss is a possibility but the extent is unknown. Pastures are providing generally adequate feed but still less than normal for the time of year.

- Good - Yield prospects are normal. Moisture levels are adequate and disease, insect damage, and weed pressures are minor. Pastures are providing adequate feed supplies for the current time of year.

- Excellent - Yield prospects are above normal. Crops are experiencing little or no stress. Disease, insect damage, and weed pressures are insignificant. Pastures are supplying feed in excess of what is normally expected at the current time of year.

The percentages in each of the five categories must sum to 100. For example, the 18-state corn condition ratings on August 1, 2016 were 1 percent very poor, 5 percent poor, 18 percent fair, 56 percent good, and 20 percent excellent. National crop planting progress, progress of development stages, and condition estimates are weighted using the program State's average planted acres over the previous three crop years.

As described in the May 22, 2017 *Crop Progress* report, progress and condition estimates are based on survey data collected each week from early April through the end of November. The non-probability crop progress and condition surveys include input from approximately 3,600 respondents whose occupations provide them opportunities to make visual observations and frequently bring them in contact with farmers in their counties. While NASS does not provide data on the composition of respondents, it is our understanding that in earlier years the vast majority were county agricultural extension agents, but as the number of agents declined over time they were replaced by others, such as Farm Service Agency staff and elevator managers. Based on standard definitions, these respondents subjectively estimate the progress of crops through various stages of development, as well as the progress of producer activities. They also provide subjective evaluations of crop conditions when the crops are mature enough to make such evaluations.

Most respondents complete their questionnaires on Friday or early Monday morning and submit them to the National Agricultural Statistics Service (NASS) Field Offices in their States by mail, telephone, fax, e-mail, or through a secured internet website. A small number of reports are completed on Thursday, Saturday, and Sunday. Regardless of when questionnaires are completed, respondents are asked to report for the entire week ending on Sunday. For reports submitted prior to the Sunday reference date, a degree of uncertainty is introduced by projections for weekend changes in progress and condition. By the end of the 2016 season, over 95 percent of the data were being submitted through the Internet website. As a result, the majority of all data are submitted on Monday morning, significantly reducing projection uncertainty.

Analysis

When considering the use of crop condition ratings to project the yield of corn and soybeans within the growing season, there are two basic approaches. The first is to estimate the relationship between end-of-season ratings and final yield and then plug the ratings into the model as they become available during the season in order to project yield. For example, the models in Figures 1 and 2 were estimated using end-of-season ratings and final yields over 1986-2016 (see last week's article for details) and could be used during the entire 2017 growing season. In essence, one is taking the current rating, projecting it to be the final rating, and then forecasting yield. The second is to estimate the relationship between ratings each week of the growing season and final yield and then plug the ratings into the model for a particular week in order to project yield. Examples of this approach are found in Figures 3 and 4, which were estimated using mid-July ratings and final yields over 1986-2016 (again see last week's article for details). This particular model could only be used for making mid-July yield projections.

There are pros and cons to either of the previous two approaches. The first approach has the advantage of simplicity as only one model is estimated for each crop and the relationship between final ratings and yield should most accurately reflect the information content of ratings with regard to yield. The disadvantage of this approach is that it does not account for any possible bias in the within season condition ratings. The advantages and disadvantages of the second approach are basically the reverse of the first. That is, estimating separate models for each week of the growing season accounts for the any bias in the condition ratings for that week, but, as shown in our article last week, model estimates early in the season may be quite inaccurate and noisy. There is no cut and dried answer to which approach is the best. We follow the first approach because we place the most weight on getting the best possible estimates of the relationship between condition ratings and yield. However, this means we have to deal with the possibility of bias in the ratings within the season, and that is what we analyze in the remainder of this article.

Figure 1. Relationship between Final Good + Excellent Crop Condition Rating and Trend-Adjusted U.S. Average Corn Yield, 1986-2016*

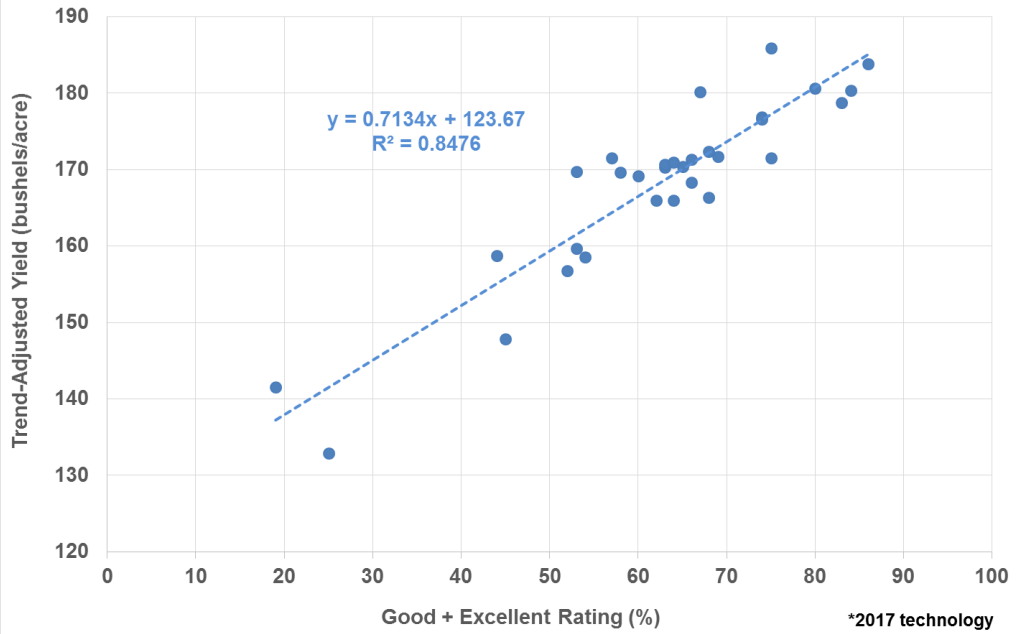$y = 0.7134x + 123.67$
$R^2 = 0.8476$

*2017 technology

Figure 2. Relationship between Final Good + Excellent Crop Condition Rating and Trend-Adjusted U.S. Average Soybean Yield, 1986-2016

$y = 0.1936x + 36.282$
$R^2 = 0.7071$

*2017 technology

Figure 3. Relationship between Mid-July Good + Excellent Crop Condition Rating and Trend-Adjusted U.S. Average Corn Yield, 1986-2016*

$y = 0.6781x + 123.76$
$R^2 = 0.6854$

*2017 technology

Figure 4. Relationship between Mid-July Good + Excellent Crop Condition Rating and Trend-Adjusted U.S. Average Soybean Yield, 1986-2016

$y = 0.1332x + 39.191$
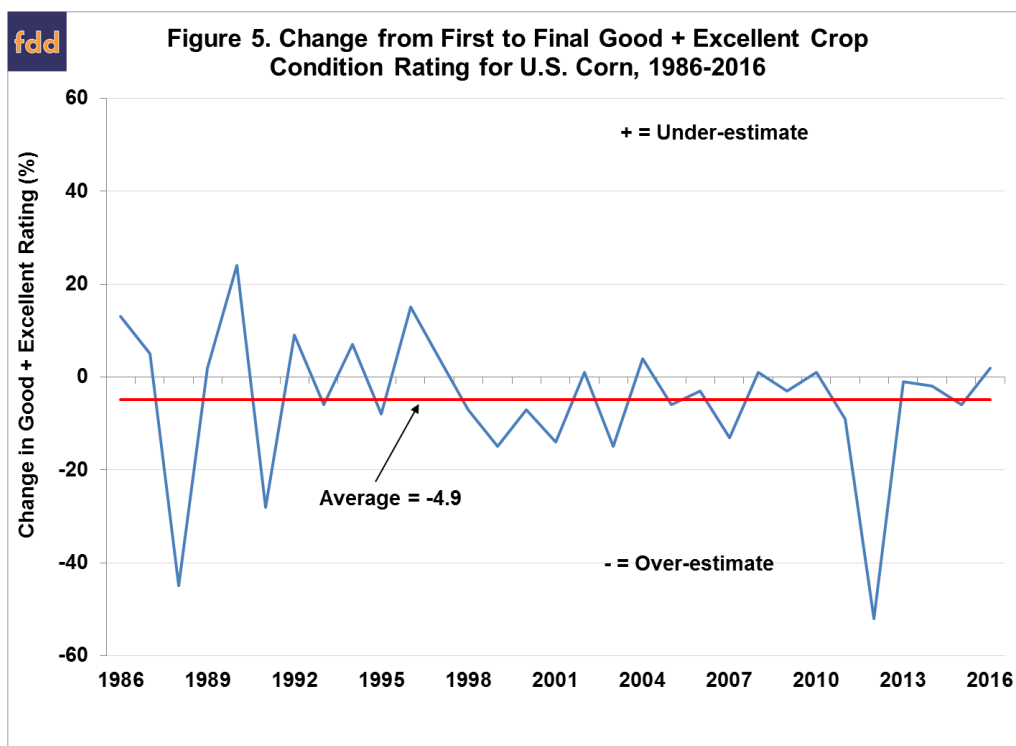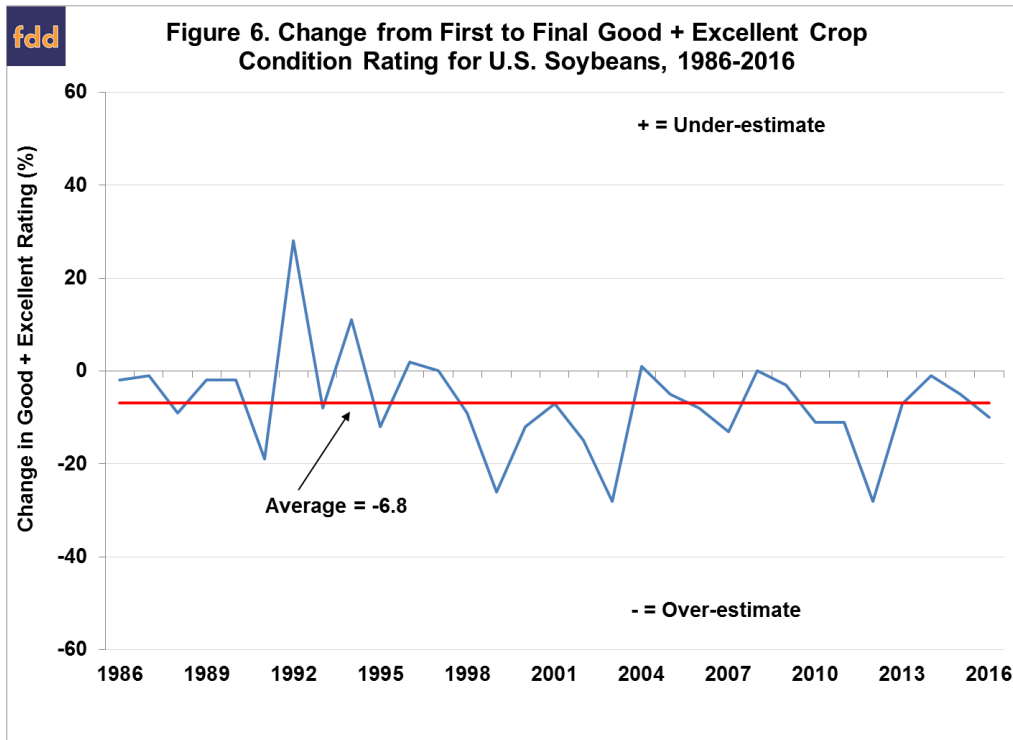$R^2 = 0.3509$

*2017 technology
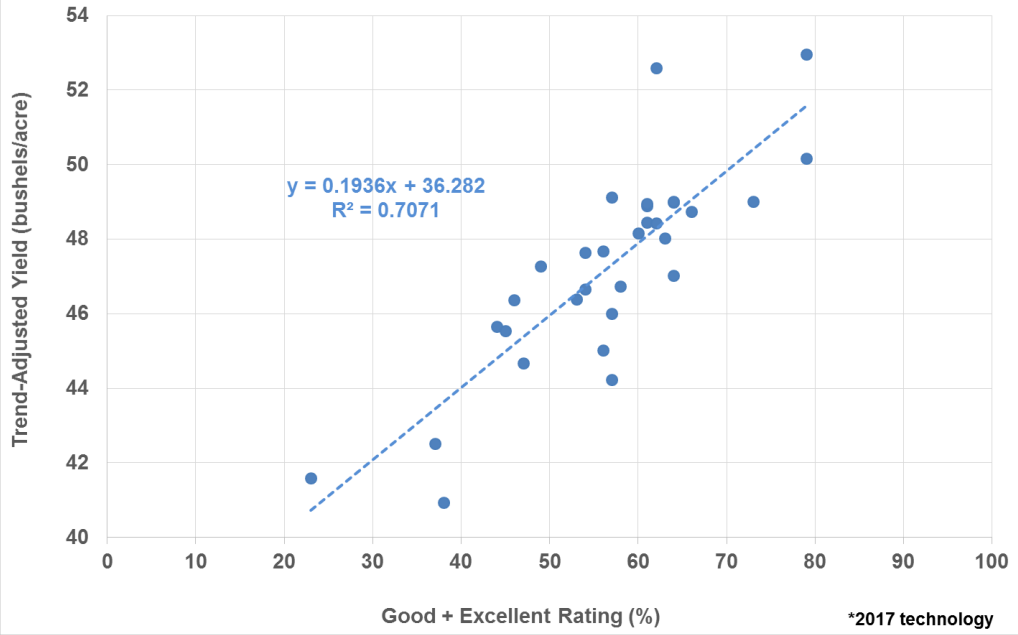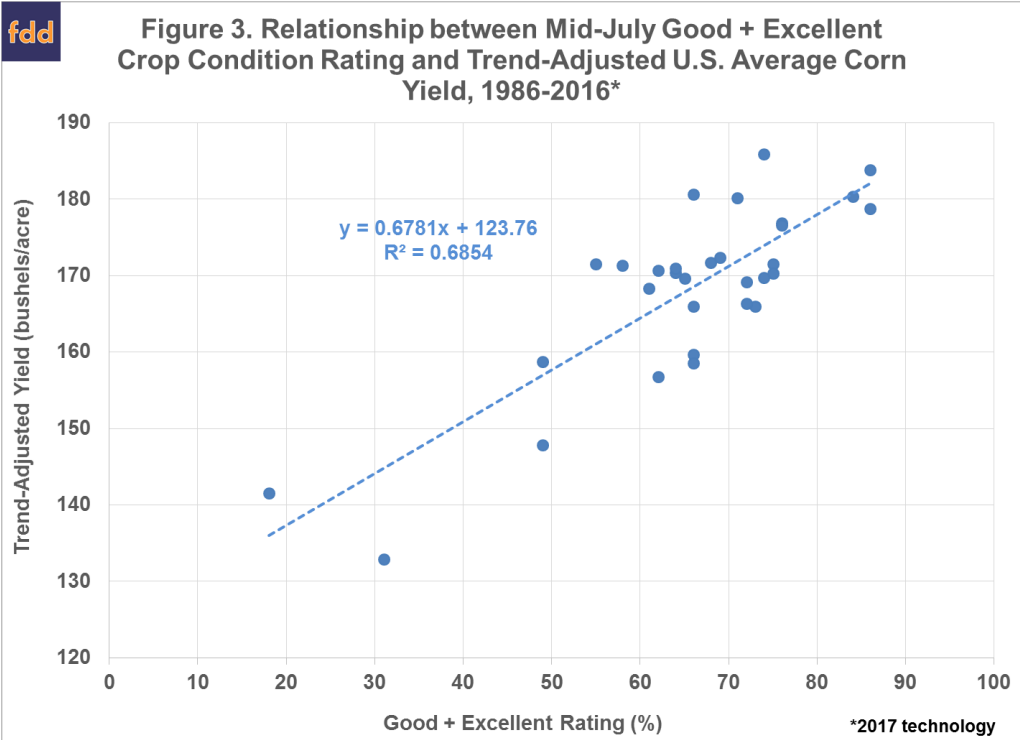
There is actually a simple and logical explanation of "bias" in early season crop condition ratings relative to final ratings. In most years, corn and soybean crops emerge in a normal fashion and actual yields end up being near normal or better in most years. Hence, it makes sense for condition ratings to be high at the beginning of many growing seasons and stay relatively high through the end of the season. This is just another way of saying that bad crop outcomes are not as frequent as good outcomes. In contrast, crop yields in a minority of years can be very poor due to adverse weather conditions and crop condition ratings can drop precipitously. This causes early season condition ratings to be biased upwards, on average, compared to final ratings. This does not mean there is anything wrong with early season condition ratings. Instead, this is just an inherent characteristic of early season ratings due to the skewed distribution of yield outcomes.

Based on the logic explained above, we should expect early season crop condition ratings for corn and soybeans to over-estimate final crop condition ratings on average. The only question then is the size of the bias. So, we examine the difference between the percentage of the crop rated in good or excellent condition each week throughout the growing season and the percentage rated in good or excellent condition in the final estimate of the year for the period 1986 through 2016. The objective is to use the historical change in condition ratings from a particular point in the season to the end of the season as a basis for projecting end–of-season ratings in real-time.
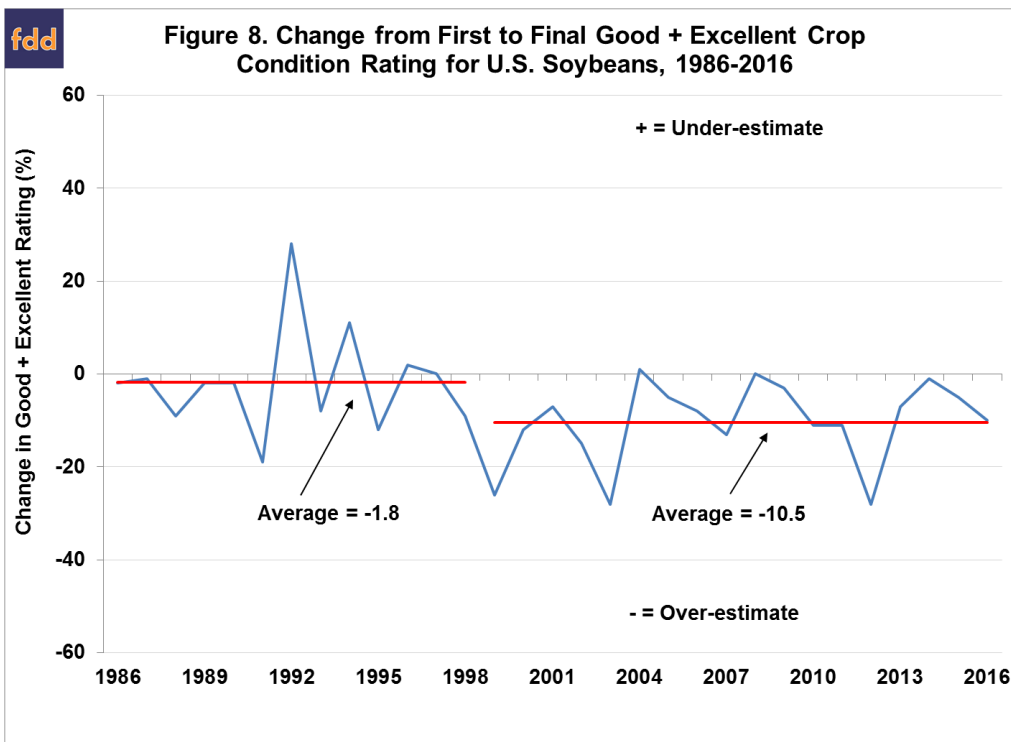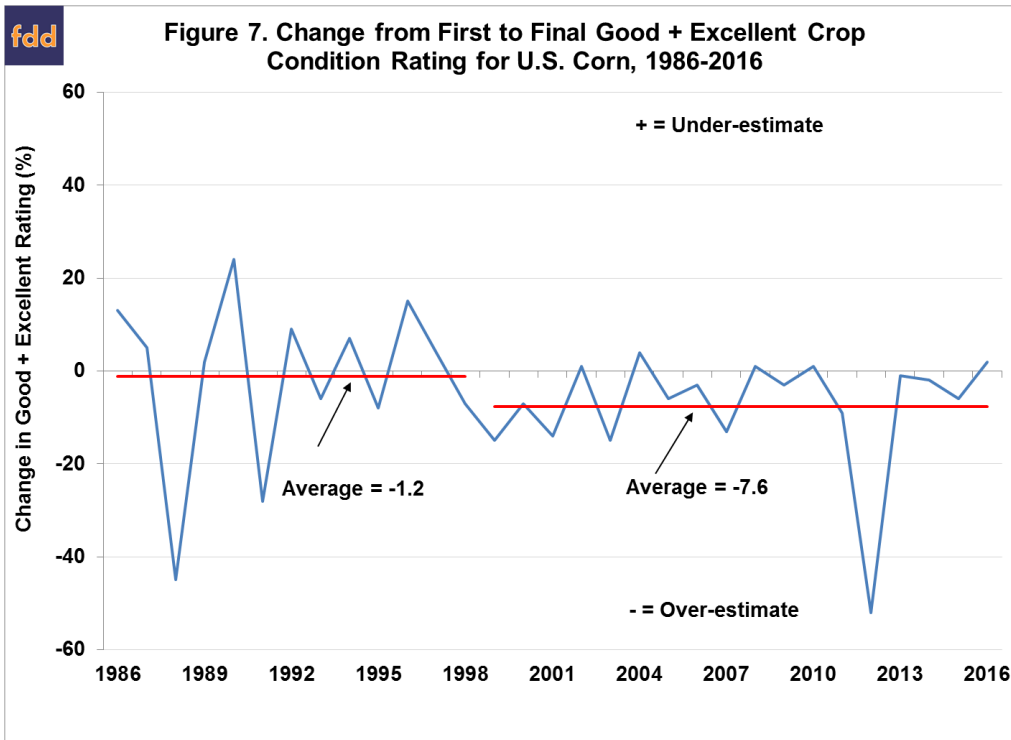
We start with the change in the percentage of the crop rated in good or excellent condition from the first to the final ratings of the season (Figures 5 and 6). For corn, the magnitude and direction of that change has varied considerably over the previous 31 years, with large changes occurring in the drought years of 1988 and 2012 when the percentage of the crop rated good or excellent declined by 45 and 52 percentage points, respectively. The largest increase, 24 percentage points occurred in 1990. There has been a tendency for ratings to decline from the first to final rating, with the percentage rated good or excellent declining in 18 years and increasing in 13 years. On average, the percentage rated good or excellent declined by 4.9 points from the first to the final rating. That is, the first rating of the season has tended to be biased, in that it over-estimated the final estimate of the percentage of the crop rated good or excellent. As noted earlier, the bias does not imply an error in the first ratings of the season, but rather that the crop typically is in good condition early in the season and then conditions either maintain or deteriorate based on adverse weather.

Figure 5. Change from First to Final Good + Excellent Crop Condition Rating for U.S. Corn, 1986-2016

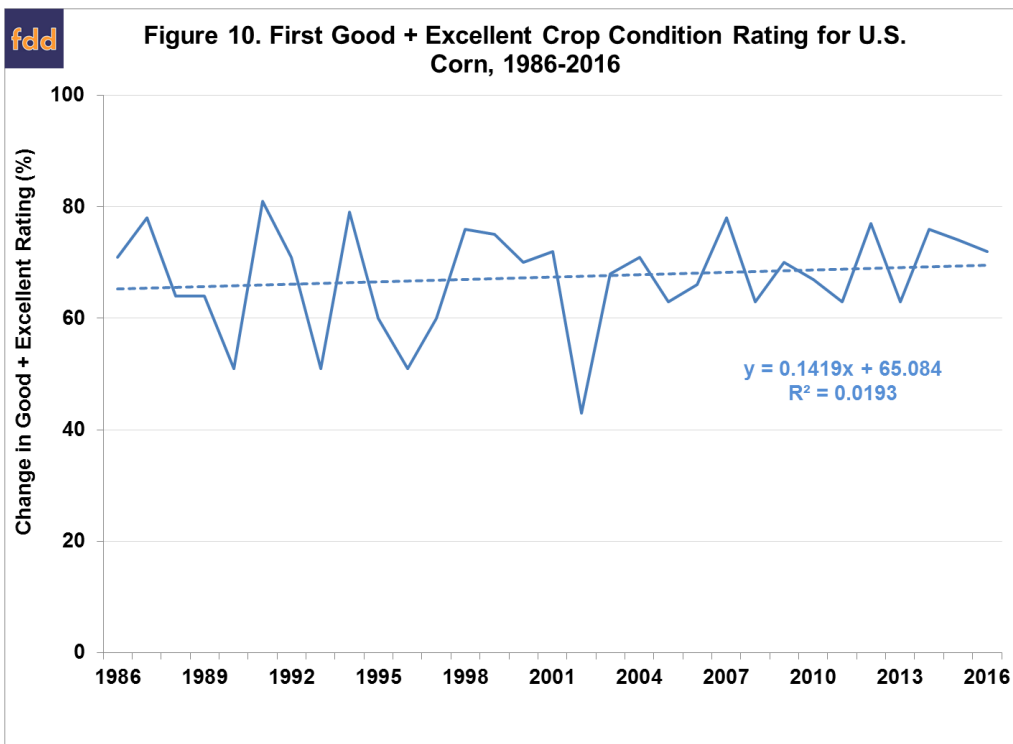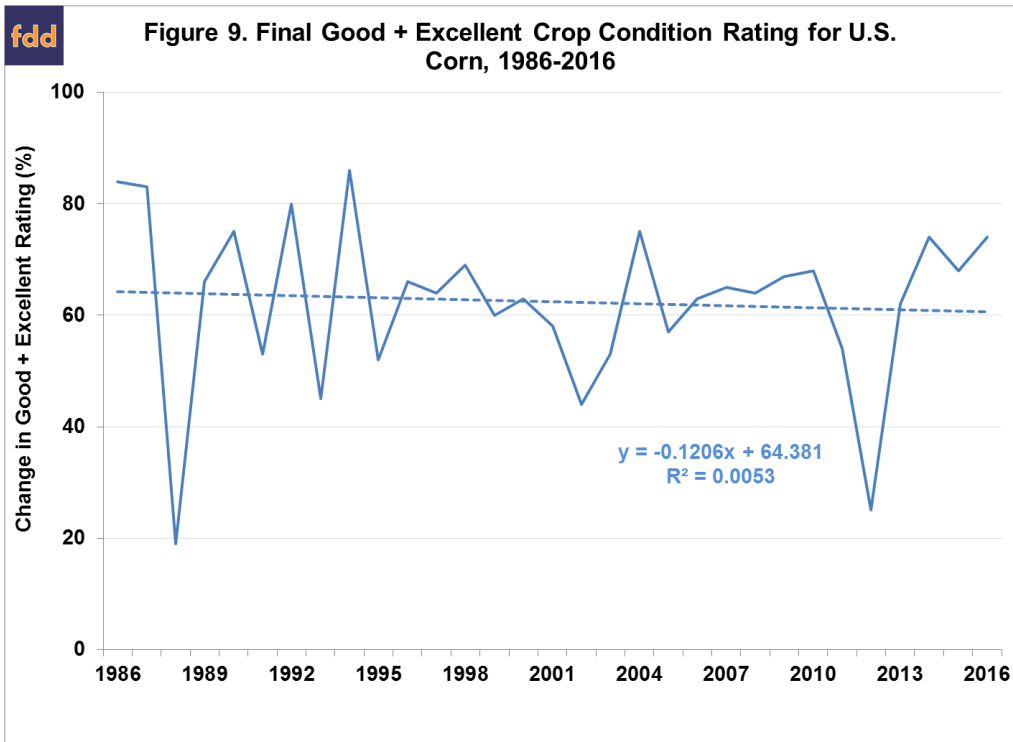**Figure 6. Change from First to Final Good + Excellent Crop Condition Rating for U.S. Soybeans, 1986-2016**

Changes in crop condition ratings for soybeans had characteristics similar to that for corn. The largest declines in the percentage of the crop rated good or excellent occurred in 1999 (26 points), 2003 (28 points), and 2012 (28 points). The percentage increased by 28 points in 1992. There has been a very pronounced tendency for ratings to decline from the first to final ratings, with the percentage rated good or excellent declining in 25 years, unchanged in two years, and increasing in only four years. On average, the percentage rated good or excellent declined by 6.8 points, so that the bias has been larger than that for corn.
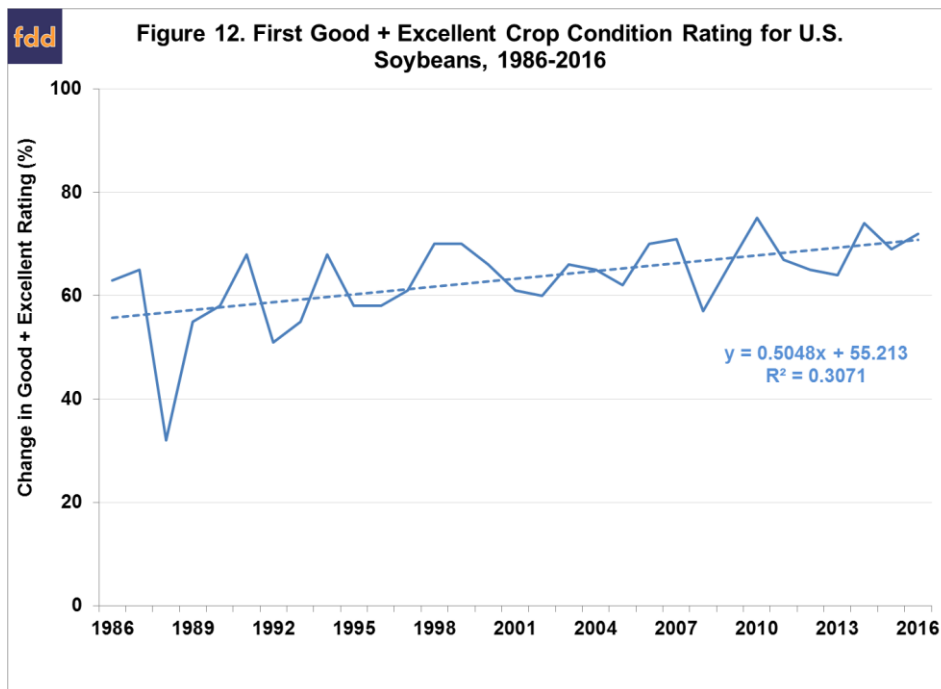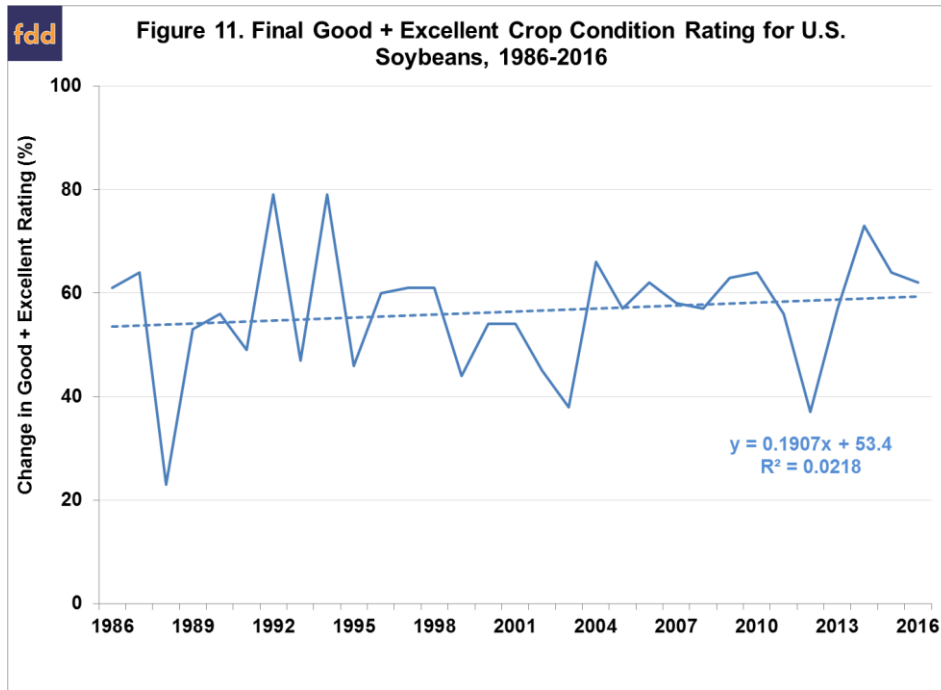
These results suggest that the first crop condition ratings of the season are biased for both corn and soybeans in that they tend to overstate the percentage of the crop that will be rated in good or excellent condition in the final ratings of the season. It is the final ratings that are highly correlated to average yield. To make the first rating useful in forming yield expectations in real time, then, the rating should be adjusted by the average size of the bias. A careful examination of Figures 5 and 6, however, reveals what appears to be a structural change in the pattern of rating changes beginning in about 1999 (Figures 7 and 8). Since 1999, the changes in the percentage of the crops rated good or excellent from the first to the final ratings have been dominated by declines for both corn (13 out of 18 years) and soybeans (16 out of 18 years) The average size of the change in the percentage of the corn crop rated good or excellent was -1.2 points from 1986 through 1998 and -7.6 points from 1999 through 2016. For soybeans, the average change was -1.8 points in the earlier period and -10.5 points in the latter period.

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Figure 7. Change from First to Final Good + Excellent Crop Condition Rating for U.S. Corn, 1986-2016

Figure 8. Change from First to Final Good + Excellent Crop Condition Rating for U.S. Soybeans, 1986-2016

The large change in the magnitude of the bias in the first crop rating of the year beginning in 1999 could be the result of a trend towards a smaller percentage of the crop rated good or excellent in the final rating, a higher percentage of the crop being rated good or excellent in the first rating, or a combination of the two. We examined those trends over the entire period from 1986 through 2016. For corn, we find a small trend towards a lower percentage of the crop rated good or excellent in the final rating (Figure 9). The trend is for a decline of about 0.12 points per year, but the trend has low explanatory power (R^2 close to zero). Conversely, we find a small trend towards a higher percentage of the crop rated good or excellent in the first rating (Figure 10). The trend is for an increase of about 0.14 points per year, but the trend has low explanatory power (R^2 of about 0.02). It appears, then, that the larger bias in the first crop rating for corn observed since 1999 is a result of a combination of a slight trend towards a higher percentage of the crop rated as good or excellent in the first rating and a lower percentage in the final rating.

Figure 9. Final Good + Excellent Crop Condition Rating for U.S. Corn, 1986-2016

$y = -0.1206x + 64.381$
$R^2 = 0.0053$

Figure 10. First Good + Excellent Crop Condition Rating for U.S. Corn, 1986-2016
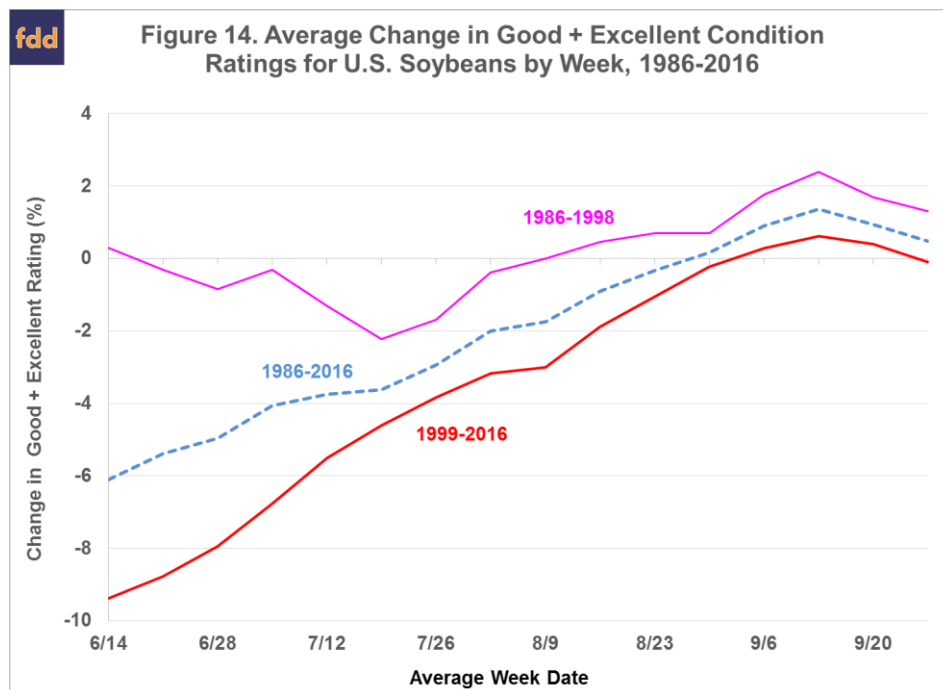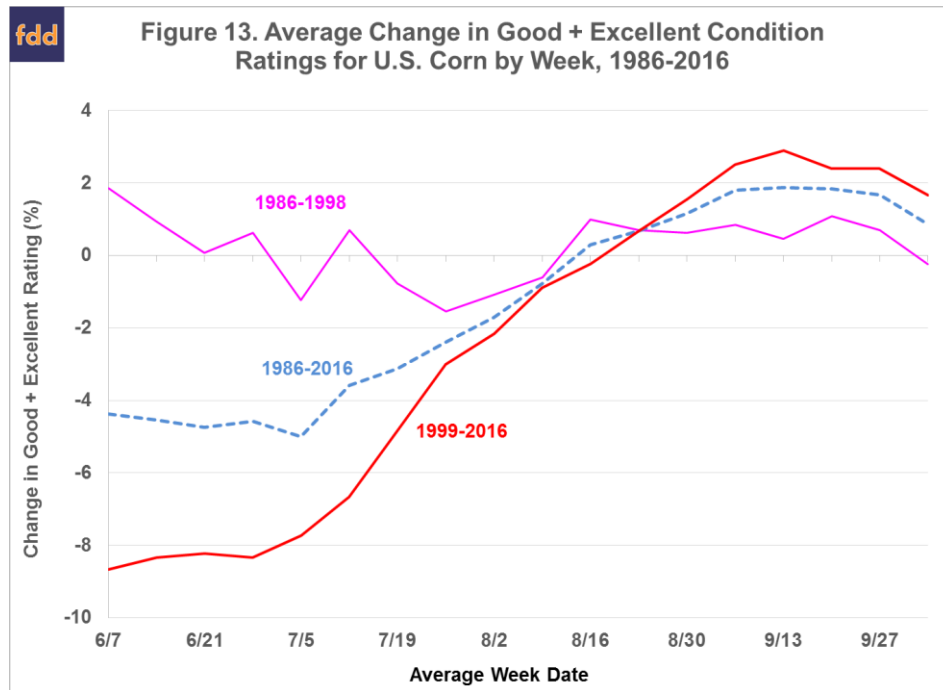
$y = 0.1419x + 65.084$
$R^2 = 0.0193$

In contrast to the results for corn, we find a slight increase in the percentage of the soybean crop rated good or excellent in the final rating. The trend is an increase of about 0.19 points per year (Figure 11), but there has been large variation so that the explanatory power of the trend is low (R2 of about 0.02). The results, however, are very different for the trend in the percentage of the crop rated in good or excellent condition in the first rating (Figure 12). The percentage of the crop rated in good or excellent condition in the first rating has increased at a rate of about 0.5 points per year, with trend explaining about 31 percent of the annual variation in those changes. The higher average bias in the first rating since 1999, then, appears to be mainly attributable to the trend towards a higher percentage of the crop being rated in good or excellent condition in the first rating.

Figure 11. Final Good + Excellent Crop Condition Rating for U.S. Soybeans, 1986-2016

$$y = 0.1907x + 53.4$$
$$R^2 = 0.0218$$

Figure 12. First Good + Excellent Crop Condition Rating for U.S. Soybeans, 1986-2016

$$y = 0.5048x + 55.213$$
$$R^2 = 0.3071$$

The reasons for the trends in crop condition ratings in the first and final ratings and the structural change observed beginning in 1999 are not known. Those changes could be related to changes in weather patterns that influence condition ratings, changes in crop production practices, or to changes in the methodology of estimating crop conditions. The trend towards earlier planting of soybeans, for example, may have contributed to the larger bias in the first rating observed since 1999. Some speculate that changes in the make-up of crop observers over time may also have contributed to the change. Regardless of the reason, going forward it is likely prudent to use the larger bias since 1999 to adjust the first rating in forming yield expectations.

We repeated the analysis depicted in Figures 5 and 6 for each week of the growing season beginning in the first week of June for corn and the second week of June for soybeans. We calculated the average change (bias) in the percentage of the crop rated good or excellent in the rating for each week and the final rating of the season. Those averages were calculated for the entire 31-year period and separately for the periods 1986 through 1998 and 1999 through 2016 (Figures 13 and 14). For corn, the magnitude

of the bias in the percentage of the crop rated good or excellent over the entire period averaged between -4 and -5 points until about mid-July, gradually approached zero by mid-August, increased to near +2 by September, and then declined at the end of the season. As expected based on the analysis of the bias in the first rating of the season, the pattern of the average weekly bias during the growing season was very different in the early and latter periods. In the early period the average weekly bias was in a very narrow range from -1.5 to +1.9 with the average bias generally less than one point from early August through the end of the season. In contrast, the average weekly bias in the latter period was near -8 points from early June to early July and then steadily approached zero by mid-August. The average bias then increased to nearly +3 by mid-September before declining slightly through the end of the season.

Figure 13. Average Change in Good + Excellent Condition Ratings for U.S. Corn by Week, 1986-2016

Figure 14. Average Change in Good + Excellent Condition Ratings for U.S. Soybeans by Week, 1986-2016

For soybeans, the patterns in the magnitude of the average weekly bias had similarities to that of corn. For the entire period, the average bias was near -6 points in mid-June, steadily approached +1 by late August, and then decline slightly through the end of the season. For the early period, the average weekly bias was near zero in mid-June, declined to about -2 by mid-July, increased to about +2 by mid-

September, and then declined slightly through the end of the season. In the latter period, the bias was near -9 points in mid-June and steadily approached zero by early September.

Implications

A widely used method of forecasting corn and soybean yields is based on the relationship between end-of-season good plus excellent crop condition ratings and final yield. One can then plug within season ratings into the model as they become available in order to project yield in real-time. However, this method can run afoul of the inherent tendency of ratings to be biased upward early in the season because the crop typically starts in good condition and then conditions either maintain or deteriorate based on adverse weather. Here, we investigate the magnitude and seasonal pattern of the bias. On average, the percentage rated good or excellent declined over 1986-2016 by 4.9 points for corn and by 6.8 points from the first to the final rating. In other words, the first rating of the season has tended to over-estimate the final estimate of the percentage of the crop rated good or excellent. We also find there was a structural change in the magnitude of the upward bias in first crop condition ratings starting in 1999. The reasons why the bias would increase so sharply are not clear.

A real-time application of the results can be made using the USDA's Crop Progress report of May 30, 2017, which indicated that 65 percent of the corn crop was rated in good or excellent condition as of May 28. Over the past 18 years, the average percentage of the crop rated good or excellent in the first rating of the year was about 8 points higher than at the end of the season. Based on that average, current crop condition ratings point to 57 percent of the crop being in good or excellent condition at the end of the season. Based on the historical relationship we estimate using data over 1986-2016, the projected average yield for 2017 would be:

$$0.7134(57) + 123.67 = 164.3 \text{ bushels per acre}$$

Since the percentage of the crop rated good or excellent at the end of the season has explained only about 85 percent of the variation in annual trend-adjusted yield since 1986 and there is some uncertainty about the best estimate of bias, this calculation obviously should be treated with considerable caution. The calculation can be updated every week based on the historical average difference between weekly and final crop condition ratings.

References

Irwin, S., and D. Good. "When Should We Start Paying Attention to Crop Condition Ratings for Corn and Soybeans?" *farmdoc daily* (7):96, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, May 24, 2017.

USDA, National Agricultural Statistics Service. *Crop Progress*, released May 22, 2017. http://usda.mannlib.cornell.edu/usda/nass/CropProg//2010s/2017/CropProg-05-22-2017.pdf