5-9-2014

Forecasting Corn and Soybean Yields With Crop Conditions

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ECONOMICS COMMENTATOR

South Dakota State University No. 547 May 9, 2014

FORECASTING CORN AND SOYBEAN YIELDS WITH CROP CONDITIONS

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Corn and soybeans are the most highly produced annual crops in South Dakota. Forecasting yield for these crops is helpful for academia, agribusiness, and producers across the state. Yield forecasts give guidance towards possible supply conditions, aid in price determination, and help make agribusiness decisions. Yields are often forecasted with a trend-line model. Recent research also suggests that yields can be forecasted using the USDA's crop conditions information.

In this commentator, we explore the use of crop conditions information as a way to refine forecasts during the growing season. Crop conditions combine objective and subjective information about the condition of the crop in a given state. The crop conditions data are broken down into five state-level categories: Excellent, Good, Fair, Poor, and Very Poor. A percentage of the crop falls into each category. For example, crop conditions for corn in South Dakota in a given week may be: 10% Excellent, 40% Good, 30% Fair, 20% Poor, and 0% Very Poor.

Crop conditions data has been released by USDA since 1986. Only in recent years has enough data been released to allow for an empirical test of the usefulness of this data for a single state. Previous research has established that there is a statistical link between crop conditions and yield. Determining the relationship between crop conditions data and yield in an individual state allows us to assess the statistical link between the two and the economic value of crop conditions data.

Yield Forecasting Models

Forecasting yield is often done using a trend-line model. This type of model is effective and useful for several reasons. This type of model is not complex and only uses a trend variable to estimate yield. Both corn and soybean yields have shown a consistent increasing trend for several decades. This increasing trend is due to new technologies that are developed to increase yields. New and improved production practices also contribute to this trend.

Research has shown that using data from the USDA's crop conditions reports can be effective to forecast yields. Kruse and Smith (1994) found that an index created using data from the USDA's weekly crop production reports can effectively explain state-level yields in corn and soybeans. Fackler and Norwood (1999) conducted a similar analysis and found similar results. More recently Bain and Fortenbery (2013) used a crop conditions index (CCI) to explain wheat yields. Jorgensen (2014) finds that state-level South Dakota corn yields can be effectively forecasted by using a CCI from mid-June until harvest.

Benefits of Forecasting Yield with a CCI

Trend-line and CCI models are both useful for forecasting yields. Trend-line models can be used to forecast yield at any time during the year, and are not dependent on any released data. A CCI model, on the other hand, requires USDA crop conditions data, and cannot be used until mid-June to forecast yields. Despite this, the CCI model has been shown to be more accurate at forecasting yield than a trend-line model (Jorgensen, 2014). Typically at mid-June a CCI model produces a yield forecast that is only around 1 bushel per acre more accurate than a trend-line corn yield model. By the end of July, the CCI model becomes 7 bushels per acre more accurate than the trend-line model.

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Finally, by mid-September the CCI model is around 8 bushels per acre more accurate than the trend-line model.

Data and Models

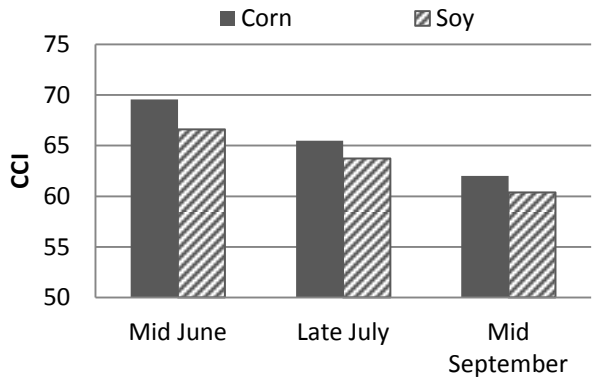
The yield data used in this study are from the National Agricultural Statistics Service (NASS) data collected from 1986 to 2013. Linear regression is used to estimate both the trend-line and CCI models. The CCI model also requires the calculation of a CCI, specified as:

CCI = (% Excellent)*1 + (% Good)*0.75 + (% Fair)*0.5 + (% Poor)*0.25 + (% Very Poor)*0

This calculation multiplies the percentage of the crop in each of the five crop conditions categories (Excellent, Good, Fair, Poor, and Very Poor) times a weight between 1 and 0. The percentage of the crop that is Excellent is weighted by 1, and the weights decrease by 0.25 for each category, with the percentage of the crop in Very Poor condition weighted at 0. The 0 weight on the Very Poor percentage of the crop is used to eliminate the effect abandoned acres has on the yield forecast (Fackler and Norwood, 1999).

Figure 1 shows the 5-year average CCI for both corn and soybeans at three points during the growing season in South Dakota.

Figure 1: 5-Year Average CCI



Corn

Corn yields in South Dakota have shown a strong increasing trend since 1986. The trend-line model for corn yield ($Yield_C$) is:

$Yield_C = 66.84 + 2.53*Trend$

Corn yield is equal to an intercept value of 66.84 plus 2.53 times the *Trend* value. Trend is equal to the number of years since the beginning of the calculation, which is 1986. For 2014, *Trend* is equal to 29. Using this trend-line model, the projected corn yield for 2014 is 140 bushels per acre.

The CCI model will not be useful until mid-June, when new crop conditions data are available. Using the 5-year average CCI levels at mid-June, the end of July, and mid-September, the CCI models of corn yield are:

$Yield_C$ (mid-June) = 2.91 + 0.92**CCI* + 2.49**Trend*

$Yield_C$ (end of July) = 5.39 + 0.89**CCI* + 2.64**Trend*

$Yield_C$ (mid-Sep.) = -2.00 + 1.02**CCI* + 2.78**Trend*

The 2014 corn yield estimate using mid-June conditions is equal to a constant of 2.91 plus 0.92 times the 5-year average CCI at mid-June plus 2.49 times the trend value of 29.

For demonstration purposes, the 5-year average CCI levels at several points during the growing season are used to show how corn conditions would predict yield this year. The 5-year average CCI at mid-June is 69.55. Using this model, the projected corn yield for 2014 is 139 bushels per acre. Similarly, the models calculations of 2014 corn yield at the end of July and mid-September are 140.5 bushels per acre and 142 bushels per acre, respectively. Figure 2 shows the 2014 corn yield forecasts from both models throughout the growing season.

Soybeans

Soybean yields in South Dakota have seen steady growth since 1986, but have not grown at a pace as fast as corn yields. The model for soybean yield ($Yield_S$) is:

$Yield_S = 27.31 + 0.39*Trend$

Soybeans yield is equal to a constant value of 27.31 plus 0.39 times the *Trend* value of 29. The growth in yield since 1986 has been 0.39 bushels per year. Using this trend-line model, the projected soybean yield for 2014 is 38.5 bushels per acre.

As with corn, the 5-year average CCI at several points during the growing season can be used to show how soybean conditions relate to yield this year. Similarly, a CCI model for soybean yields is more accurate than a trend-line model, and its accuracy increases as the growing season progresses. At mid-June, the end of July, and mid-September, the CCI models of soybean yield ($Yield_S$) are:

$Yield_S$ (mid-June) = 10.1 + 0.24**CCI*+ 0.42**Trend*

$Yield_S$ (end of July) = 11.12 + 0.23**CCI*+ 0.43**Trend*

$Yield_S$ (mid-Sep.) = 0.01 + 0.39**CCI*+ 0.51**Trend*

The 2014 soybean yield estimate using the mid-June model is equal to a constant of 10.1 plus 0.24 times the 5-year average CCI at mid-June plus 0.42 times the trend value of 29. The 5-year average CCI is 66.6. Using this model, the projected soybean yield for 2014 is 38.2 bushels per acre. Similarly, the model calculations of soybean yield at the end of July and mid-September are 38.3 bushels per acre and 38.5 bushels per acre, respectively. Figure 3 shows the 2014 soybean yield forecasts from both models throughout the growing season.

Summary

Both the trend-line and CCI models can be used to forecast corn and soybean yields in South Dakota. Both types of model have their benefits and drawbacks. The trend-line model can be estimated at any time of the year, but is less accurate than the CCI model. The CCI model is not useful as early as the trend-line model, but allows a more accurate yield forecast that changes with crop conditions throughout the growing season.

The CCI models for both corn and soybeans show that the yield forecast increases as the growing season progresses. The corn CCI forecast ultimately surpasses the trend-line forecast, while the soybean CCI forecast converges to the trend-line forecast. Note that the CCI model is based on 5-year average CCI values at the selected points in time, and the actual 2014 CCI values for these times could vary drastically from these averages. To improve the forecasts provided in this paper, use the true CCI values at the points in time provided in the CCI model yield equations.

Figure 2: 2014 Corn Yield Forecasts

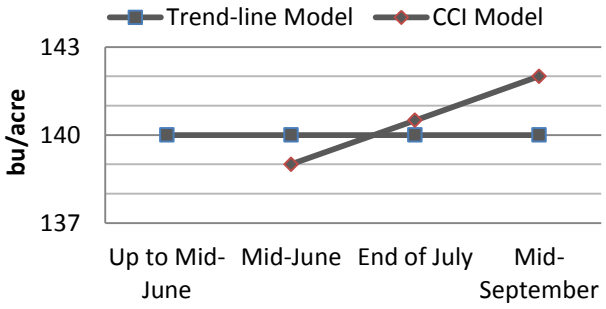


Figure 3: 2014 Soybean Yield Forecasts

References

Bain, R. & Fortenbery, T.R. (2013). Impacts of Crop Conditions Reports on National and Local Wheat Markets. *NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management*, (pp. 1-27), St. Louis.

Fackler, P. L. & Norwood, B. (1999). Forecasting Crop Yields and Condition Indices. *NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management*, (pp. 1-18), Chicago.

Jorgensen, N. (2014). *A Comparison of Corn Yield Forecasting Models*. Masters Thesis, South Dakota State University, Department of Economics.

Kruse, J.R. & Smith, D. (1994). *Yield Estimation Throughout the Growing Season*. Ames: Center for Agricultural and Rural Development.

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