Forecasting Cotton Yields over the Southeastern US using NOAA/NCEP Climate Forecast System

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Justification
During the summertime there is only weak predictability associated with ENSO in the southeastern USA, making it difficult to forecast seasonal climate and yields to improve agricultural practices. The use of forecasted meteorological variables directly from Global Circulation Models (GCMs) are a viable alternative to categorical ENSO-phase predictions.

Objective
To apply the NOAA/NCEP Climate Forecast System (CFS) forecasts to forecast cotton lint yields at a county scale in the southeastern USA.

Methods
• Calculate the first Principal Component (PC1) of the de-trended cotton yields.
• Average of the 62 weather stations April-May-June total rainfall.
• Extract PC1 of 2m temperatures from Reanalysis in the geographical domain of the southeastern United States.
• Extract PC1 of 2m temperatures from CFS in the same geographical domain.
• Correct Reanalysis and CFS PC1s in years where rainfall average were lower than 250mm.
• Predict cotton yields PC1 (1987 – 2006) using corrected 2m temperatures Reanalysis PC1 using retroactive validation.

Data (1970-2006)
Cotton yields:
• De-trended data from 57 Counties in Alabama and Georgia (USA/NASS)

Atmospheric conditions:
• April-May-June total rainfall from 62 weather stations (NCDC)
• July-August-September 2m temperatures (NCEP/NCAR CDAS Reanalysis)
• June 0.5 – 2.5 2m temperature forecasts (NOAA/NCEP CFS)

Results and Discussion

Correcting 2m temperature PCs
Cumulative rainfall below 250 mm during the growing phenological phase (April-May-June) negatively affects cotton yields (Fig. 2). Consequently, PC1’s temporal scores during those years received a penalty proportional to the driest year. The penalty was assessed by relating the rainfall deficit and the threshold ratios. The method of Mean Squares was used to fit the new temporal scores (Fig. 3).

Predicting cotton yields
The PC1 extracted from Reanalysis of 2m temperatures, corrected by observed April-May-June rainfall, significantly predicted cotton yields in 31 counties (Fig. 4b). This increased the cotton yield predictability in the southeastern USA in comparison to the ENSO-based hindcasts (Fig. 4a). After applying a retroactive validation, the Goodness-of-Fit Index (GFI) was 0.5274.

Hindcasting cotton yields
The use of CFS’s hindcasts significantly hindcasted cotton yields in 48% of the counties predicted using Reanalysis (Fig. 4c). For those counties, the GFI was 0.5247 and the RMSE ranged between 13.6% and 28.2% after applying a retroactive ‘coral reef’ (CR) validation.

Conclusions
• Cotton lint yields in some counties of the southeastern USA can be significantly forecasted three months before harvesting using June 0.5 – 2.5 forecasts of 2m temperatures from the NOAA/NCEP CFS and observed total rainfall during the cotton growing phenological phase (April-May-June).

Reference

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