Simulating the Impact of Climate Variability on Crop Rotations in the Southeastern USA

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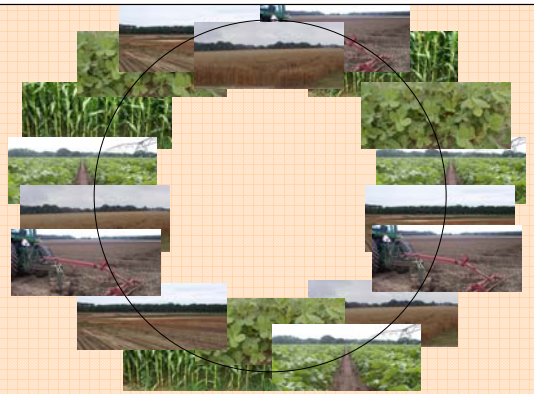
Introduction

- Crops rotations are an important component for farming systems with impact on weed control, pest development, yield potential, and economic return.
- Rotation studies must be long-term in order to complete several full cycles that can provide insights of their impact on crop yield.
- Nonetheless, long-term simulations, coupled with field research data, may provide a satisfactory understanding of the effect of the rotations on crop yield after only two or three seasons of field data (Staggenborg & Vanderlip, 2005).
- Decision support systems integrate the complexity of a farming system and can help understand the impact of long-term rotation sequences as well as the impact of climate variability and cropping systems on yield.
- The objective of this study was to evaluate the capability of the Decision Support System for Agrotechnology Transfer (DSSAT) for simulating yield of cotton, maize, and peanut under various crop rotation sequences for selected farms in southwest Georgia.

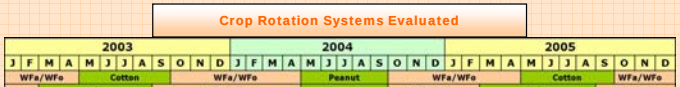
Typical Rotation System for Major Crops in Southwest Georgia, USA



Materials and Methods

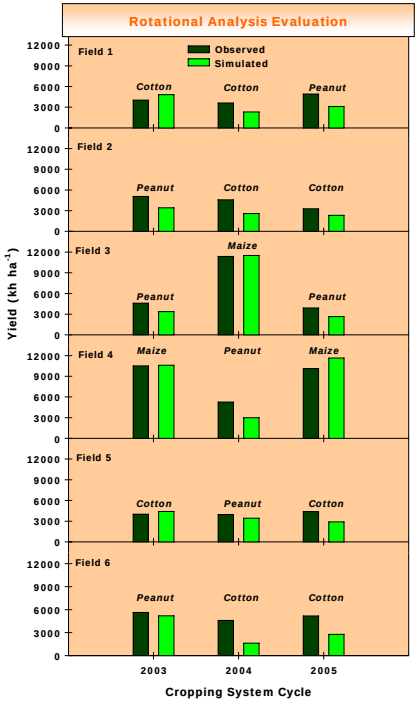
- Experimental data for cotton, maize, and peanut were obtained from six fields of three selected farmers in southwest Georgia from an on-farm crop's growth monitoring conducted during the 2003 to 2005 cropping seasons.
- Samplings for growth analysis were conducted at two week interval.
- Weather data collected by the weather stations of the Georgia Automated Environmental Monitoring Network (AEMN) were used.
- Soil profile information was obtained from the National Soil Characterization Data of the USDA-NRCS (National Resources Conservation Service).
- The sequence analysis program (Bowen et al., 1998) and the Cropping System Model (CSM) model of the Decision Support System for Agrotechnology Transfer (DSSAT v4) (Jones et al., 2003; Hoogenboom et al., 2004) was used for simulating three rotation sequences that were observed in the farmers' fields.
- The rotation systems evaluated were Cotton-Cotton-Peanut (C-C-P), Cotton-Peanut-Cotton (C-P-C), and Maize-Peanut-Maize (M-P-M) as the main crop components and winter forage (WFo) or winter fallow (WFa) as complements.

Crop Rotation Systems Evaluated



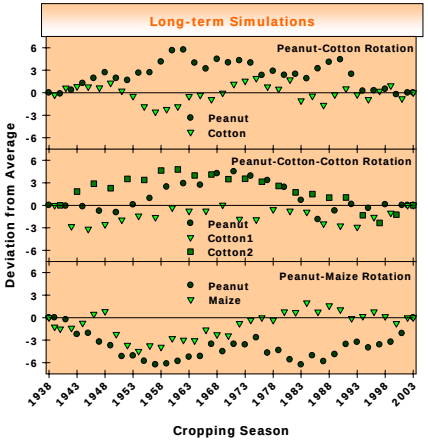
Results

Rotational Analysis Evaluation



- Fields 1 and 2 are located in Mitchell County and the farmer uses winter forage as a complement to his combination of peanut and cotton rotation systems.
- Fields 3 and 4 area located in Mitchell County and belong to a farmer who traditionally plants maize and peanut as the main crop components to his rotation and winter fallow as a complement.
- Fields 5 and 6 are located in Newton County and belong to a farmer whose rotation includes winter forage as a complement.

Long-term Simulations



Peanut-Cotton Rotation

- Except for short periods, simulated peanut yield for this rotation system was consistently below average.
- Simulated cotton yield tended to be above average.

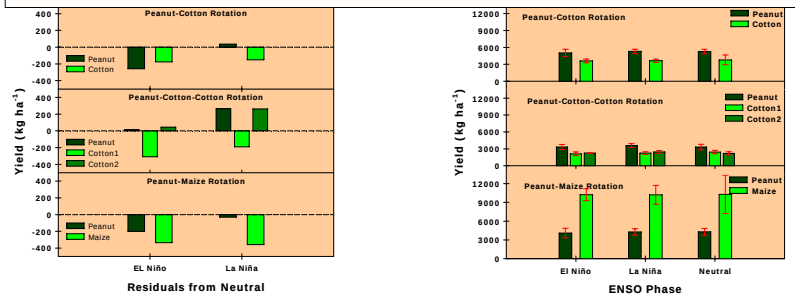
Peanut-Cotton-Cotton Rotation

- This cropping system seemed to be more satisfactory for peanut yield. Except for some short periods, yield was above average.
- Cotton after peanut (Cotton1) produced a consistent below average yield.
- A cotton followed by cotton (cotton2) seemed to be favored from previous crops; the yield is consistently above average. The availability of nutrients might be the main raison for the tendency observed for both, Cotton1 and Cotton2; however, this issue was not studied.

Peanut-Maize Rotation

- Except for short few years at the beginning of the period, simulated peanut yield tended to be below average. Conversely, simulated maize yield tended to be above average.

Impact of Climate Variability



- A Low impact of ENSO phases on simulated cotton, maize, and peanut yields was observed. Peanut from the Peanut-Cotton rotation system, as well as peanut and cotton (third main component) yields from the Peanut-Cotton-Cotton rotation system during La Niña and El Niño events showed a slight yield increase with respect to Neutral years.
- Yields from rotations including two main crops as principal components seemed to be more affected by the ENSO phases than yields from rotations including three main crops as principal component, probably because the higher probability of the crop's exposure.

Conclusion

- Yield from the various rotation sequences was simulated well. The results demonstrated the capability of the DSSAT as an effective tool for cropping systems research.
- Further studies will focus on the impact of the climate variability on long-term rotations of the major crops in the southeastern USA using the DSSAT system.

References

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Acknowledgements

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