Agricultural Research in SECC: A Systems Analysis Approach

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University of Georgia
Climate in the Southeast: Why should farmers care?
ENSO and Tomato Spotted Wilt Virus (TSWV) severity in peanut

(a). Leaf symptoms of TSWV on peanut

(b). Western Flower Thrips (vector)

* Courtesy of Dr. D. Riley, UGA
ENSO and Tomato Spotted Wilt Virus (TSWV) severity in peanut

Field observations (188 fields, 5 seasons)
Impact of ENSO and Planting Date on TSWV severity in peanut

* Planting “After June 5” not available for La Niña
Climate in the Southeast: How do farmers make decisions?
Farmers and Climate Interviews

- 38 farmers
- 21 counties in GA
- Semi-structured interviews
  - Risk management strategies
  - Access of weather & climate information
Farmers and Climate Risk Reducing Options

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<td>Land management</td>
<td>13</td>
</tr>
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<td>Variety selection</td>
<td>11</td>
</tr>
<tr>
<td>Marketing</td>
<td>8</td>
</tr>
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<td>Harvesting dates</td>
<td>4</td>
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<td>Insurance</td>
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## Farmers and Climate Risk Reducing Options

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### Forecast Use: Irwin County

Spring 2006 forecast for summer drought → widespread shift from long- to short-cycle peanut variety.
Farmers and Climate: Why models?

• Traditional agronomic approach:
  – Experimental trial and error

• Systems Approach
  – Computer models
  – Experimental data

• Understand $\rightarrow$ Predict $\rightarrow$ Control & Manage
  – (H. Nix, 1983)

• $\rightarrow$ Options for adaptive management and risk reduction
Linkage Between Data and Simulations

- Model credibility and evaluation
- Input data needs:
  - Weather and soil data
  - Crop Management
  - Specific crop and cultivar information
  - Economic data
Model Calibration
Peanut, variety “Georgia Green”
Statewide variety trials

- “Best” variety trials selected
  - Irrigated
  - Very high yields
  - No reported pest and disease pressure
  - No reported water stress
- Selected variety trials
  Tifton: 1994
  Midville: 1996
Georgia Peanut Variety Trials
Model calibration

Simulated seed yield (kg ha\(^{-1}\))

Measured seed yield (kg ha\(^{-1}\))

1:1 line

Measured

RMSE = 78 kg ha\(^{-1}\)
Evaluation of the Peanut Model
Farmers’ fields: Georgia, 2003

Mitchell County – Field 1

Baker County – Field 3

Field 1

Field 3

RMSE = 264.8
d = 0.996

RMSE = 974.9

d = 0.95
Generalized Likelihood Uncertainty Estimation (GLUE)

Data from experiments are used to estimate genetic coefficients for crop models.
Generalized Likelihood Uncertainty Estimation (GLUE)

Data from experiments are used to estimate genetic coefficients for crop models.

Coefficients are estimated and predicted yield uncertainty is reduced.
Spatial Data
Alabama, Florida and Georgia

• County level data
• Long-term historical weather data for each county.
• Three representative soil profiles for each county
• Crop management options:
  – Crop selection
  – Variety selection
  – Planting date
  – Irrigated versus rainfed
  – Fertilizer applications
  – Prices and production costs
Simulations: Cotton Yield
Variety “DP555 BG/RR”, 9 planting dates, rainfed vs irrigated; 38 – 107 years
Crop Simulations

- Historical weather data (1900-2005)
- ENSO Phases
- Planting dates
- Soil types
- Select AL, FL, GA counties

April 16, 23
May 1, 8, 15, 22, 29
June 5, 12

Yield
Total amount of irrigation
No. of irrigation events

CSM-CROPGRO Peanut Model

DSSAT Version 4
Crop Simulations: Research Analysis

Georgia

Irrigation Management

<table>
<thead>
<tr>
<th></th>
<th>Non-irrigated</th>
<th>Irrigated</th>
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</thead>
<tbody>
<tr>
<td>Normal Mean (μ)</td>
<td>2381.54</td>
<td>6145.00</td>
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<tr>
<td>Kernel C Value</td>
<td>0.79</td>
<td>0.79</td>
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El Niño

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<tr>
<th></th>
<th>Percent</th>
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<tr>
<td>Normal Mean (μ)</td>
<td>2298.36</td>
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<tr>
<td>Kernel C Value</td>
<td>0.79</td>
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La Niña

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<td>Normal Mean (μ)</td>
<td>2281.47</td>
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<td>Kernel C Value</td>
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Neutral

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<td>Normal Mean (μ)</td>
<td>6311.68</td>
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<td>Kernel C Value</td>
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Crop Simulations: AgroClimate Extension, Producers and Consultants

### Crop Simulation Interface

#### Crop Selection
- **PEANUT**

#### Variety
- Mid Maturity

#### State
- GA

#### County
- BAKER

#### Soil
- Orangeburg Loamy Sand

#### Planting Dates
- Apr 16
- Apr 23
- May 1
- May 6
- May 11
- May 16
- May 21
- May 26
- Jun 5
- Jun 12

#### Costs/Revenues
- **Crop Revenue ($/ton)**: 354
- **Irrigation Cost ($/ac.in)**: 2.85

#### Yield History
- **Average Irrigated Yield (lb/ac)**: 4000
- **Average Non-Irrigated Yield (lb/ac)**: 2800

#### Irrigation Seasonal Output
- **Net Return ($/ac)**
- **Irrigation Cost ($/ac)**
- **Irrigation Water (in)**

#### Non-Irrigated Seasonal Output
- **Net Return ($/ac)**

#### Current Forecast
- **Neutral**
- **El Niño**
- **La Niña**
- **All Years**

#### Graphs
- **Probability Distribution of Achieving Net Return**
- Click on the graph above to see the details.
Crop Simulations: AgroClimate Spatial Analysis - Policy Makers
Water Use by Agriculture
Monthly Total Irrigation (mm) in SW Georgia

2002

2003

Observed
Simulated

Observed
Simulated

June

June

July

July

August

August

September

September

Latitude
Longitude

Latitude
Longitude

Latitude
Longitude

Latitude
Longitude

Temperature
Drought Monitoring
Agricultural Reference Index for Drought (ARID)
Simple with a high spatial and temporal resolution
and physical and physiologically based

Correlation of ARID and other drought indices with the
drought stress factor of complex maize model
Agriculture and Biofuel
Energy flow analysis
Agriculture and Biofuel
Net Energy Value as a Function of Irrigation Management Practices

Coffee County, Alabama
Bulloch County, Georgia
Suwannee County, Florida
Jackson County, Florida
Floyd County, Georgia
Mitchell County, Georgia

Net energy value (MJ L⁻¹)

Irrigation depth 30 cm
Irrigation depth 60 cm

threshold 30%
threshold 50%
threshold 70%
threshold 30%
threshold 50%
threshold 70%
threshold 30%
threshold 50%
threshold 70%
threshold 30%
threshold 50%
threshold 70%
Agriculture and New Crops
Sweet corn as an alternate crop for targeted market windows

Bledsoe Research Farm
Pike Co, GA

Observed no. ears (ears ha\(^{-1}\))

Simulated no. ears (ears ha\(^{-1}\))

Genotype su
Genotype sh2
Genotype se

RMSE = 6479
d = 0.78

Observed fresh weight ears (kg ha\(^{-1}\))

Simulated fresh weight ears (kg ha\(^{-1}\))

RMSE = 2383
d = 0.80
Agriculture and Climate Change
Impact and Adaptation
Camilla, Mitchell County, Georgia

Maximum and Minimum Temperature

Precipitation
Corn Yield (kg/ha)
Agriculture and Climate Change
Mitchell County, Georgia
4 varieties, 3 soils, rainfed and irrigated

Historical weather

GCM-Modified
CSIROMK2, Scenario IS92a, 2010-2039
Climate in the Southeast: How do farmers make decisions?

AgroClimate - A service of the Southeast Climate Consortium - AgroClimate provides important new tools to help agricultural producers in the Southeastern United States understand and plan for weather and climate conditions.

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AgroClimate Tools
Forecasts and Outlooks
Ecological Risk
Crops
Freeze Risk Maps
Fruits
Cooling/Harvesting Degree Days
Forestry
Drought
Forage & Livestock
KBDI Maps
Climate and El Nino
Lawn and Garden Moisture
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KBDI Maps
Forecasts of the Krutch-Byram Drought Index (KBDI)
Lawn and Garden Moisture
Monitoring provided by the Alabama Office of the State Climatologist
Drought
Crop Development
Growing Degree Days
Chill Accumulation
Chill Accumulation Maps
Peanut irrigation forecast based on ENSO phases
Map of average residuals (%) for El Niño, La Niña, and Neutral years
Yield risk based on location, planting date, soil type and climate scenario
Peanut irrigation forecast based on ENSO phases
Growing Degree Days
GDD forecast, historical patterns, and probability, associated with ENSO Phases
Chill Accumulation
Forecasts of expected chill hours (45°F) and chill units accumulation for selected fruit crops
Chill Accumulation Maps
Chill accumulation for seasonal and biweekly periods from Oct 1 through April 30
Climate in the Southeast: How do farmers make decisions?

Interaction & Participation

Climate-based Management Options

Web-based DSS www.AgroClimate.org

Extension Agents & Specialists
Farmers/Growers

Needs for Specific Commodities

Crop Models & Climate-based Tools

Stand alone Decision Aid Tools

Forecasts, Climatology

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Climate-based Management Options