THE DEVELOPMENT OF AN AGRICULTURAL DROUGHT VULNERABILITY ASSESSMENT TOOL FOR PENNSYLVANIA

Valerie Mebane and Rick Day

Project Goal

- Improve the understanding of agricultural drought risk in Pennsylvania through the development of a drought assessment tool that can assess the vulnerability of Pennsylvania's diverse soils to agricultural drought

Agricultural Drought

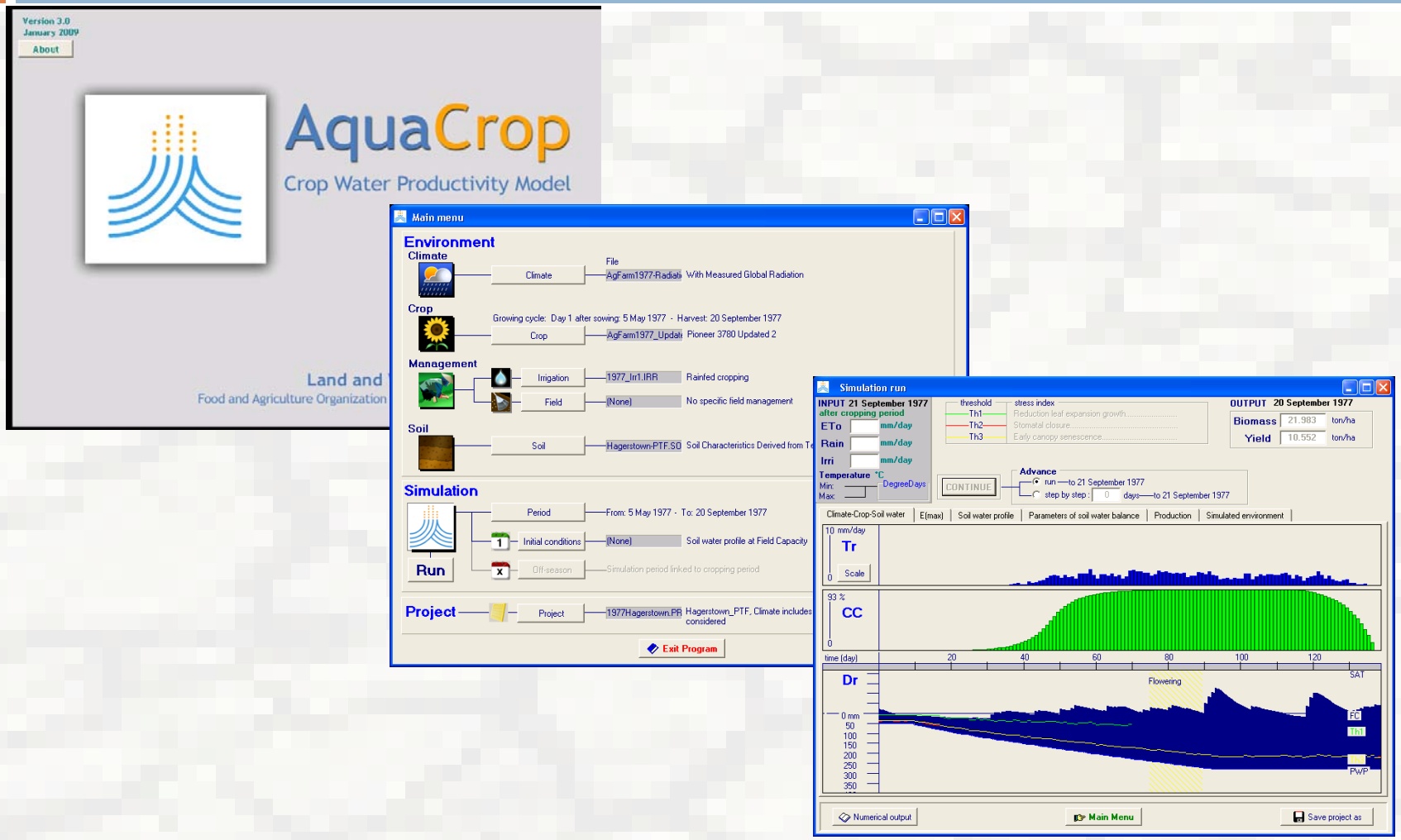
- Drought is the primary contributor to crop failure
- Results from an inability to meet plant water demands due to soil moisture stress
- Short term moisture deficits during critical stages of crop development can severely reduce yields

Drought Indices

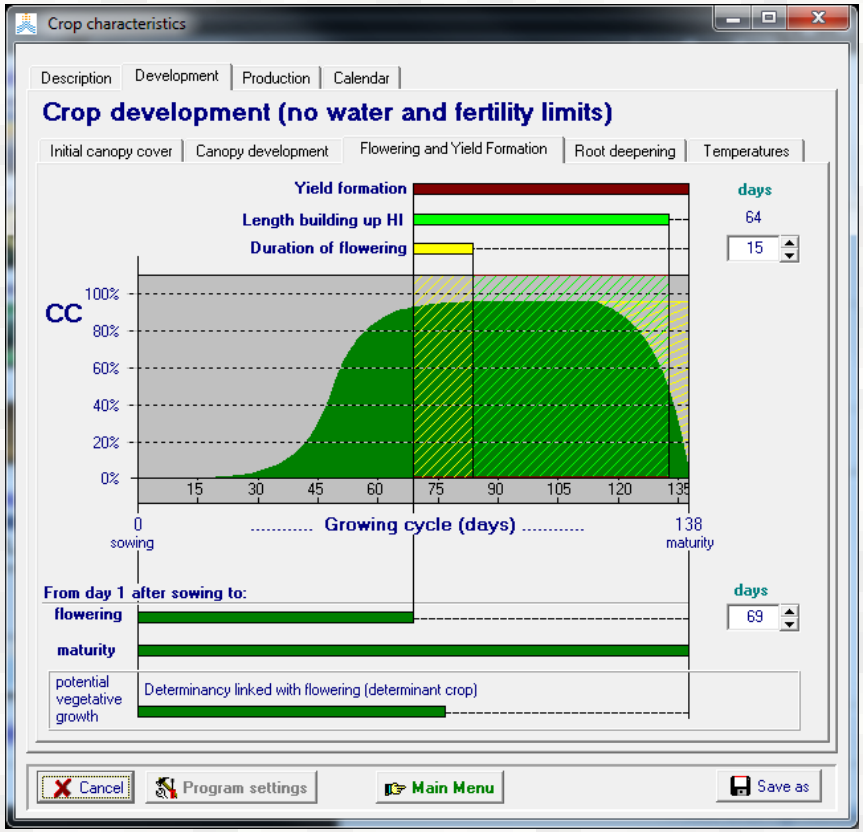
- Widely used drought indices:
  - Palmer Drought Severity Index (PDSI)
  - Crop Moisture Index (CMI)
  - Surface Water Supply Index (SWSI)
  - Standardized Precipitation Index (SPI)
  - Normalized Difference Vegetation Index (NDVI)
  - Vegetation Condition Index (VCI)

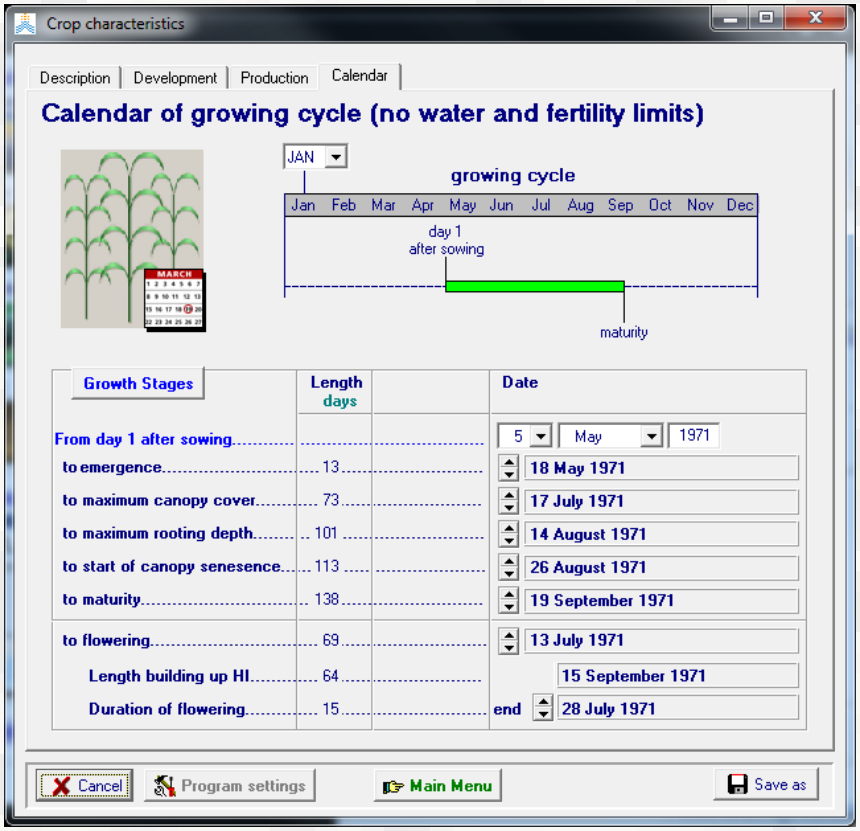
Crop Models

AquaCrop: The FAO Crop Model

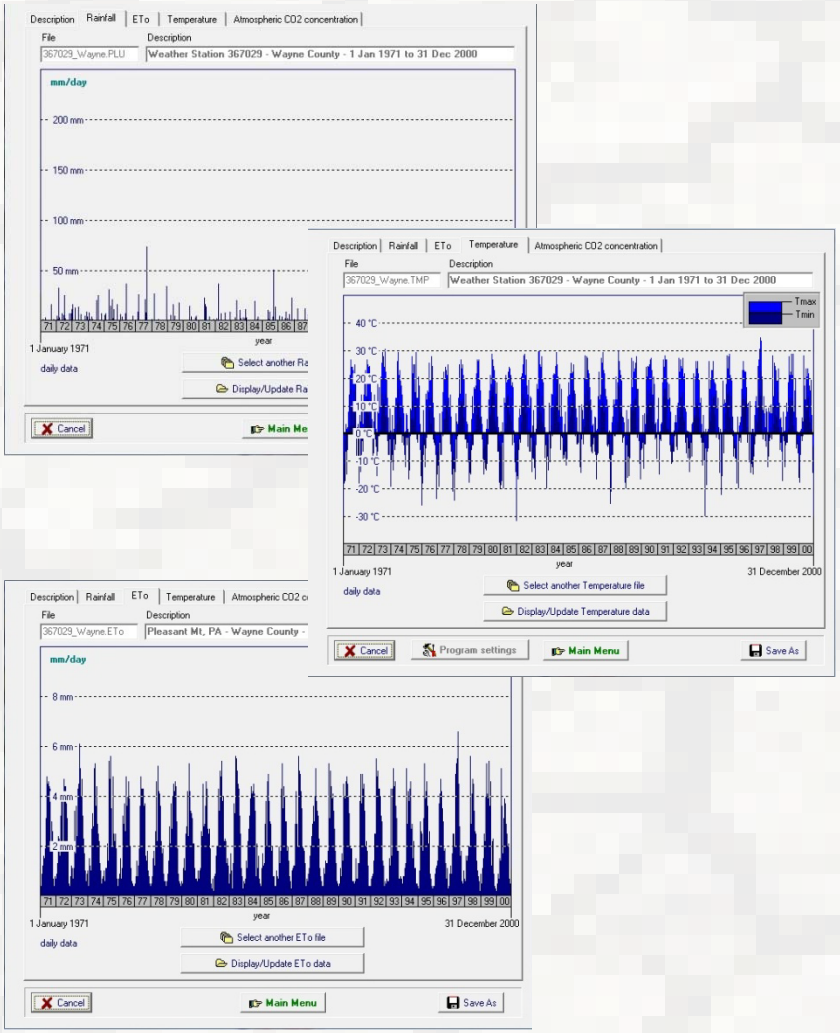


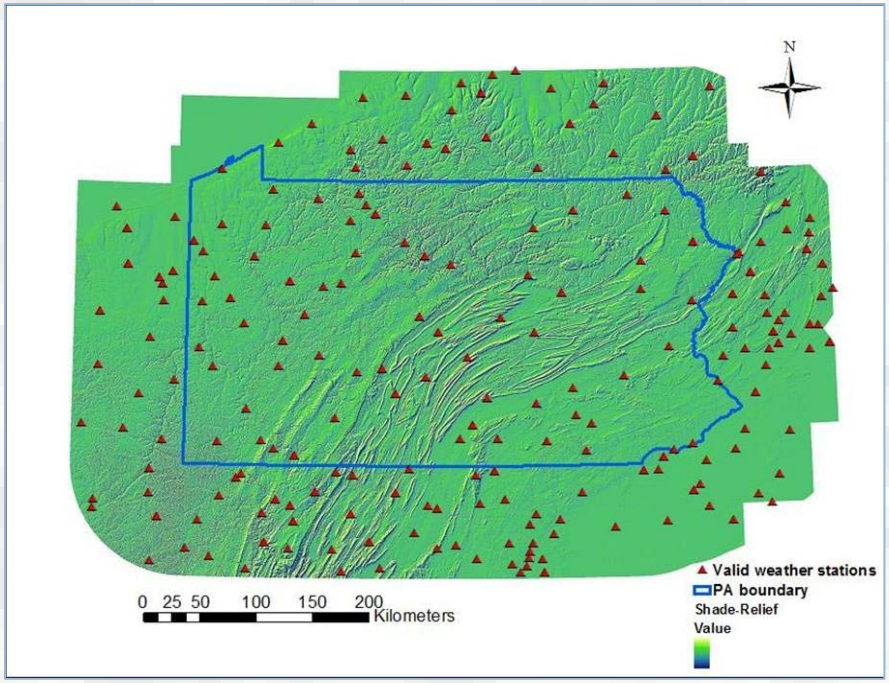
AquaCrop Inputs: Crop Characteristics



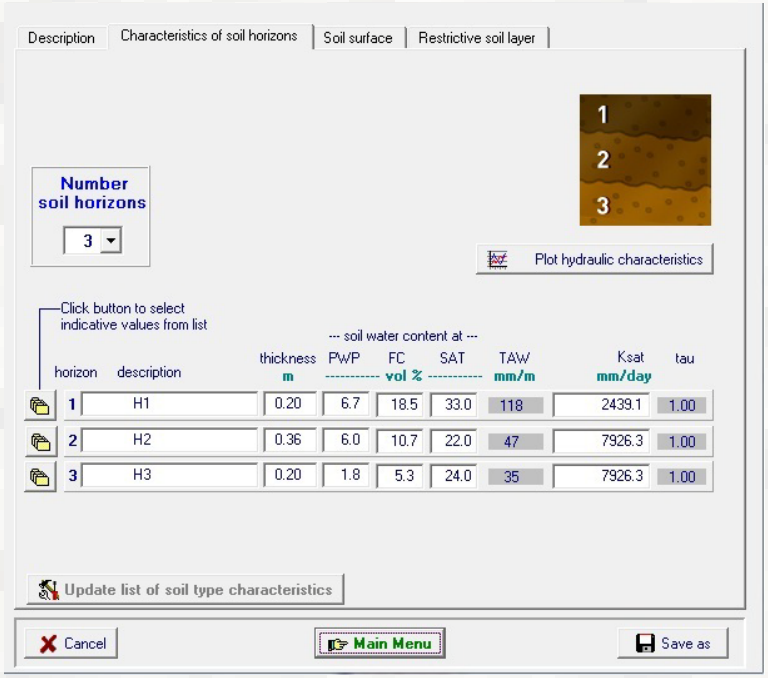


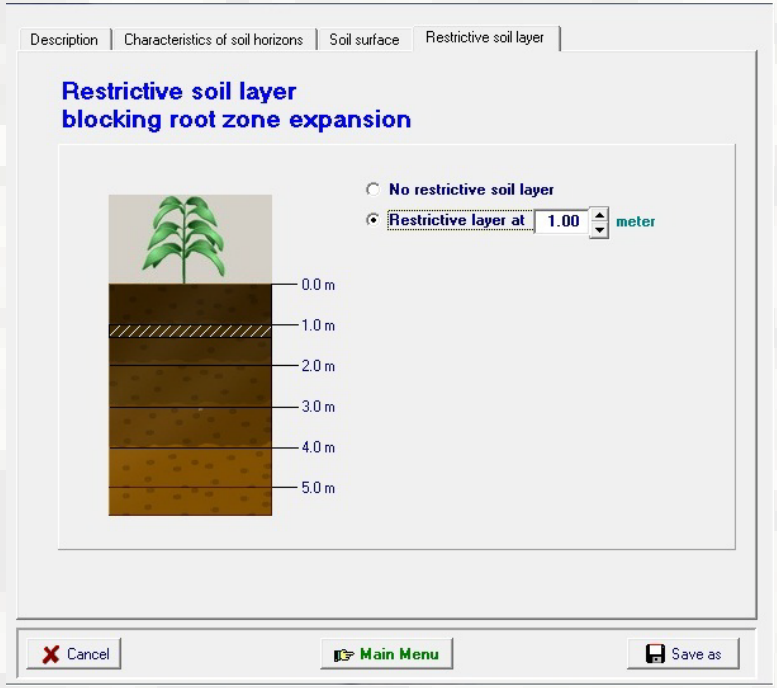
AquaCrop Inputs: Climatic Data



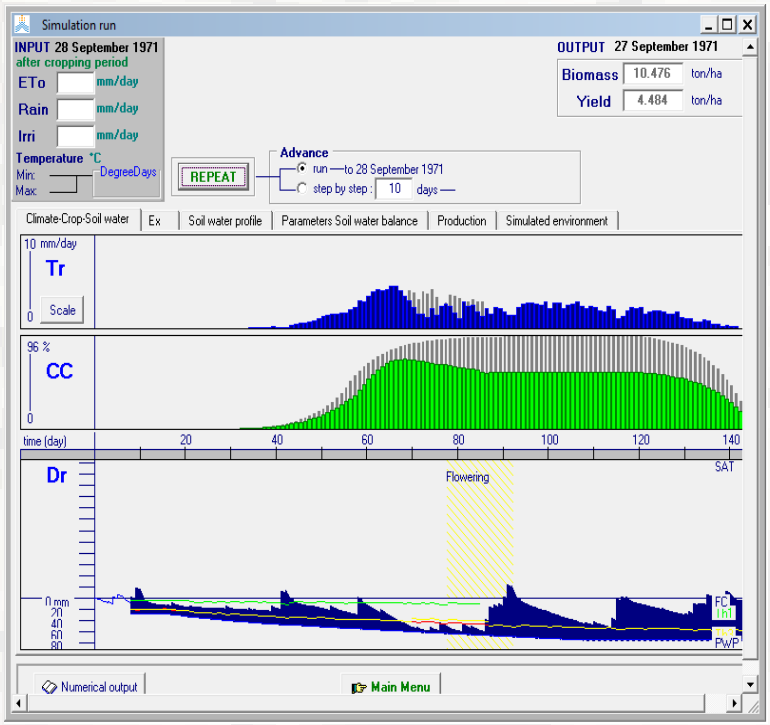


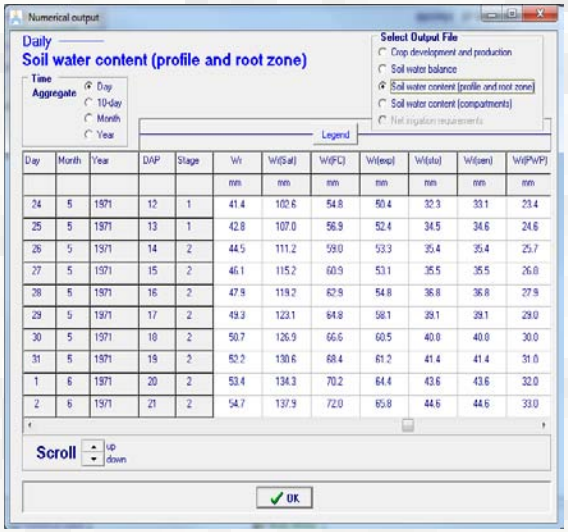
AquaCrop Inputs:
Soil Profile Characteristics

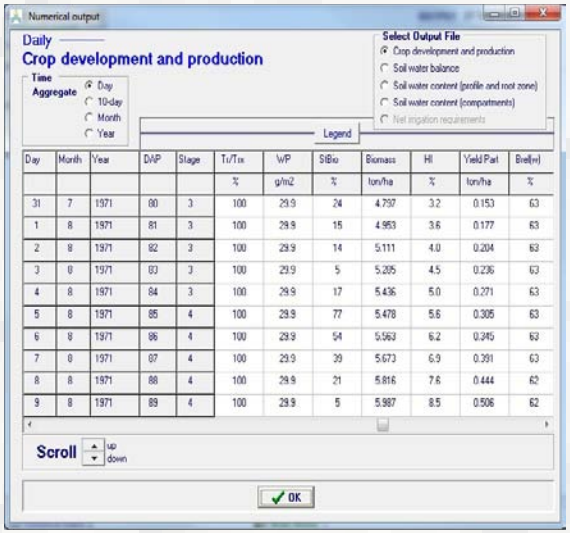




AquaCrop Outputs







Objectives

- Validate the ability of AquaCrop to simulate maize crop yields in Pennsylvania
- Develop a drought index to quantify the effects of soil type on agricultural drought vulnerability
- Generate an agricultural drought risk prediction map for Pennsylvania soils

Study Area

- Initial study will focus on a transect of nine counties that span across Pennsylvania's temperature and precip

Methods: Objective 1
AquaCrop Validation

- Assess the ability of AquaCrop to simulate:
  - Biomass Growth
  - Final Biomass
  - Harvestable Yield
- Compare simulated and observed data
  - RMSE (root mean square error)
  - IoA (Index of Agreement)

Methods: Objective 2
Drought Index Development

- Conduct a daily soil water balance for agricultural soils
- Calculate daily root zone depletion (Dr)
- Calculate daily Total Available Water (TAW)
- Calculate daily Readily Available Water (RAW)
- Calculate daily water stress coefficient:

$$\frac{TAW - Dr}{TAW - RAW}$$ (Allen et al. 1998)

Methods: Objective 2
Drought Index Development

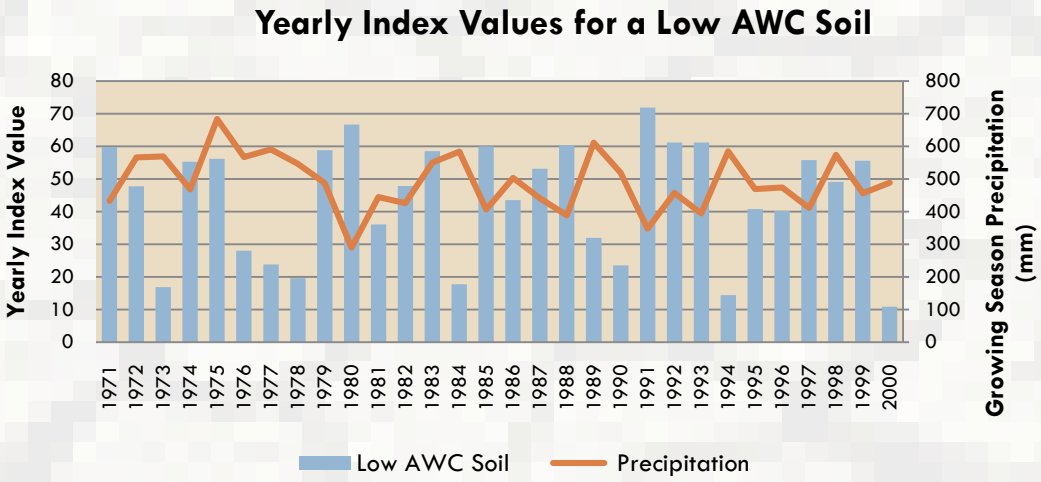
- Calculate Daily Stress Index (S_D)
- Calculate a Weighted Daily Stress Index
  - Weights (W):
    - Establishment and vegetative stages: 0.4
    - Flowering stage: 1.5
    - Yield Formation stage: 0.5

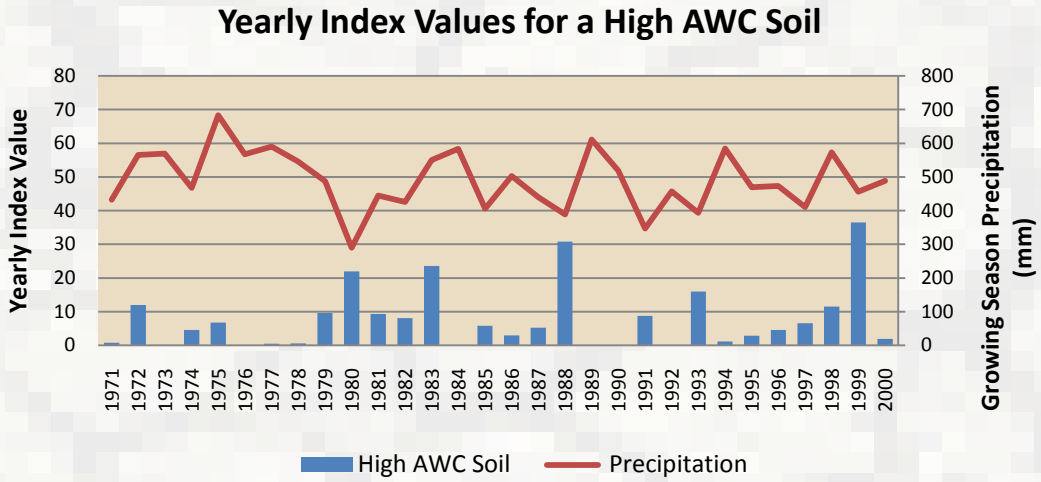
    (Doorenbos and Kassam, 1979)

- Calculate Seasonal Water Stress Index:

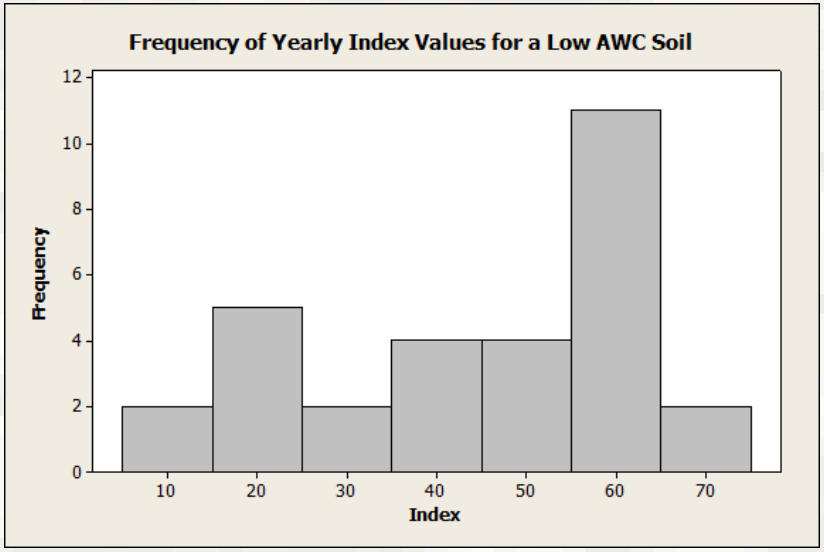
$$= \sum_{i=1}^{n} (W_i)(S_{Di})$$ (Timlin et al., 1986)

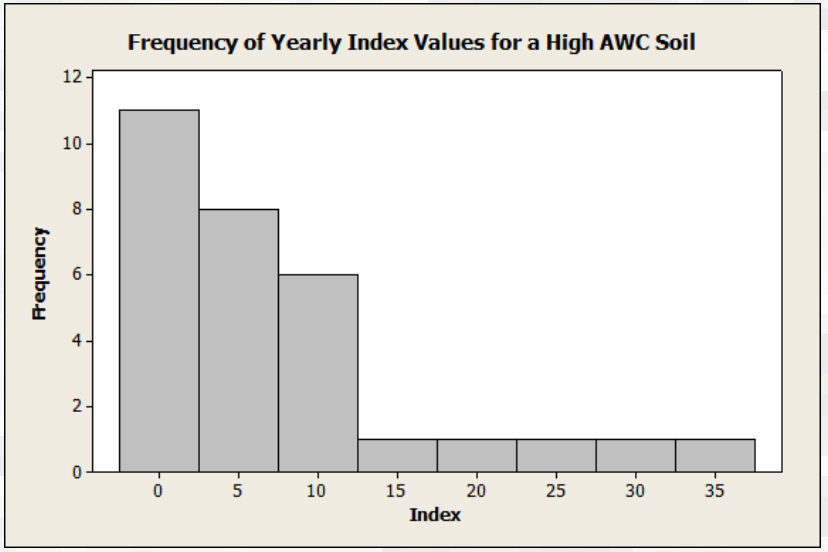
Preliminary Results



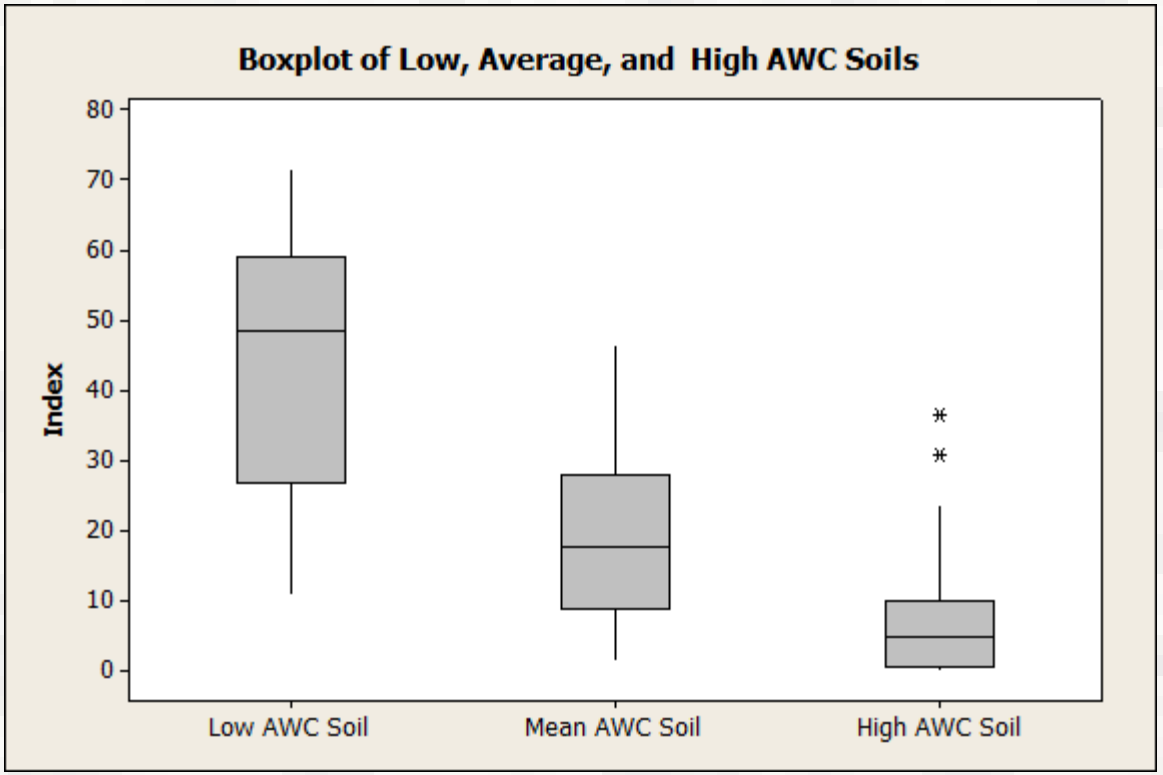


Preliminary Results





Preliminary Results



Methods: Objective 3 Prediction Map

- Develop the agricultural drought risk prediction map
  - Delineate polygons that represent the land area applicable to each weather station
  - Soils data from a SSURGO soil polygon will be combined with the climatic data from the representative station
  - Each soil polygon with similar characteristics within the boundary of the same climatic station will be assigned the same drought vulnerability index

What's Next

- Continue AquaCrop validation
- Continue processing the index values
- Finalize the relationship that relates the seasonal stress index to relative yield decreases
- Develop prediction map

Funding Acknowledgement

USDA NIFA

United States Department of Agriculture National Institute of Food and Agriculture

RGIS – Chesapeake

National Consortium for Rural and Geospatial Innovations in America - Chesapeake