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

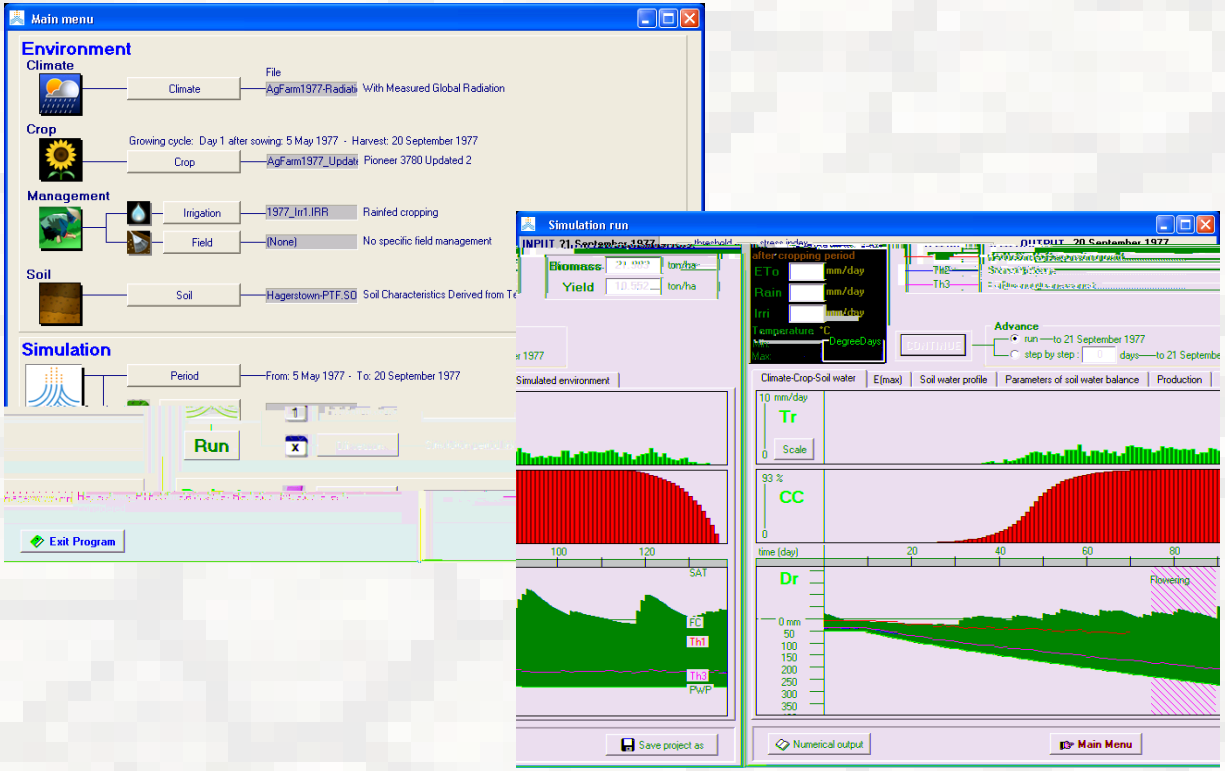
Drought Indices

Widely used drought indices:

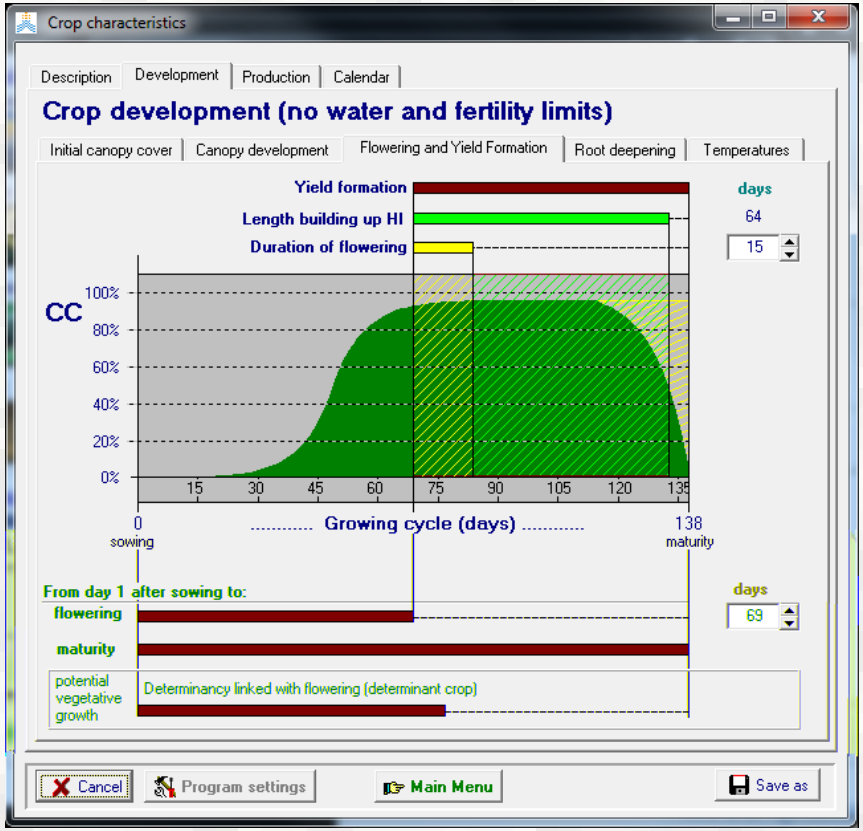
- Palmer Drought Severity Index (PDSI)
- Crop Moisture Index (CMI)
- Surface Water Supply Index (SWSI)
- Standardized Precipitation Index (SPI)
- Normalized Difference Vegetation Index (NDVI)
- Vegetation Condition Index (VCI)

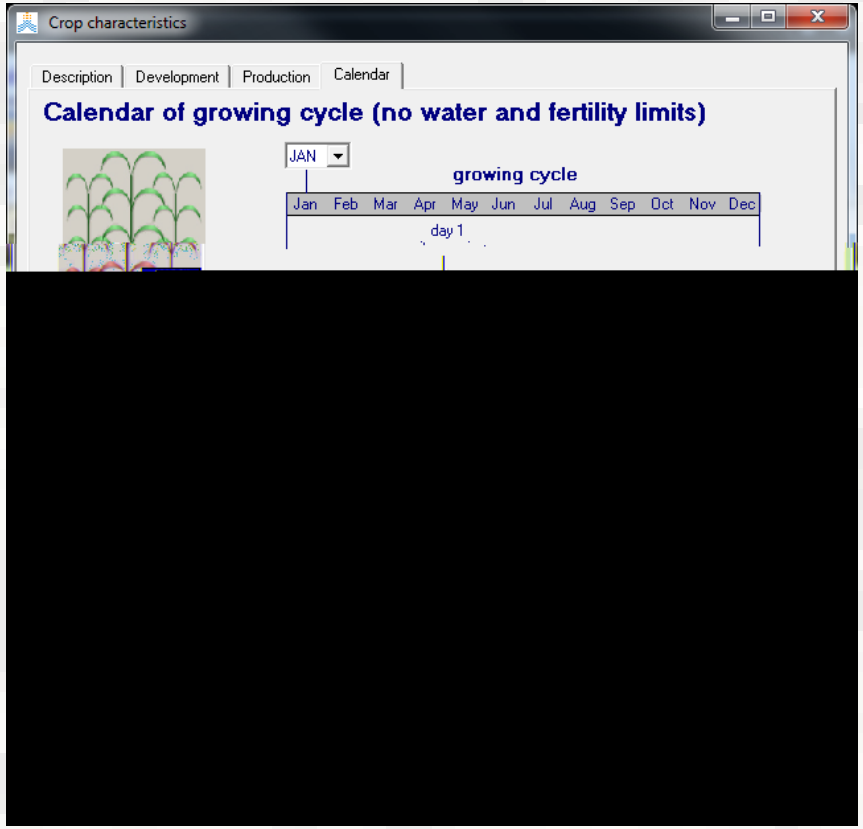
Crop Models

AquaCrop: The FAO Crop Model

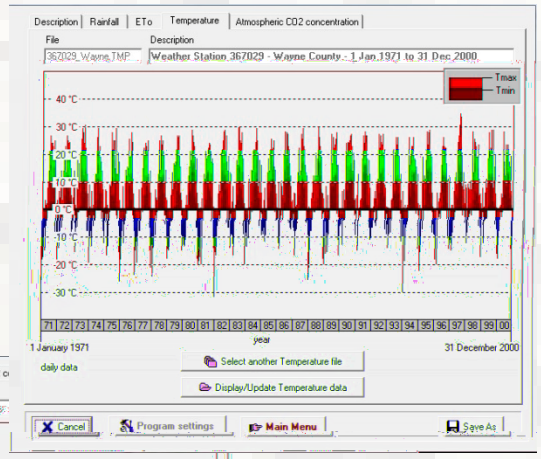


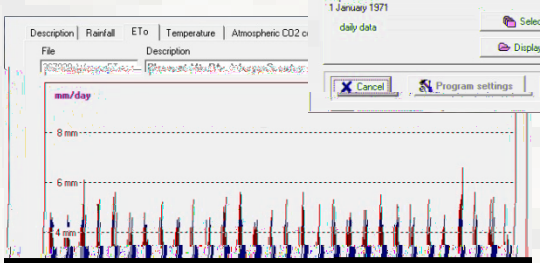
AquaCrop Inputs: Crop Characteristics





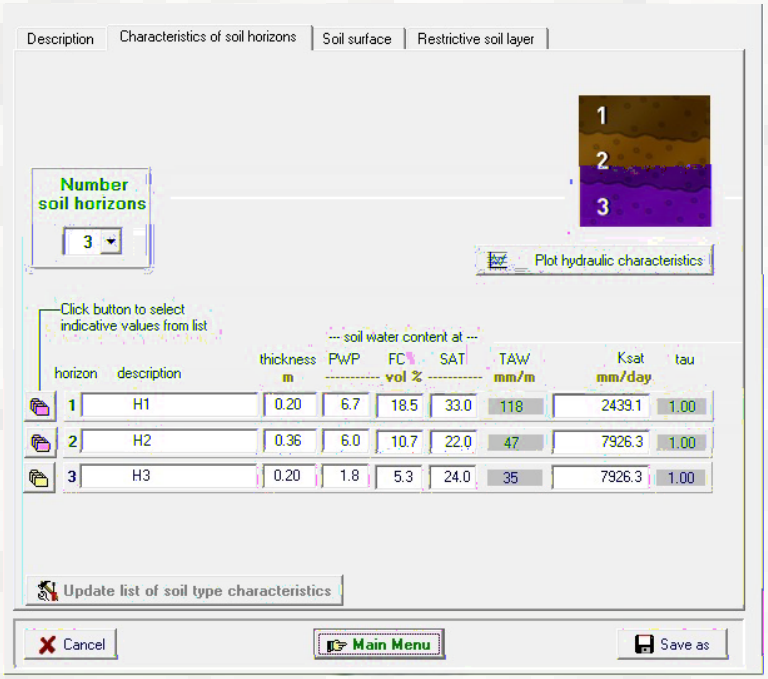
AquaCrop Inputs: Climatic Data

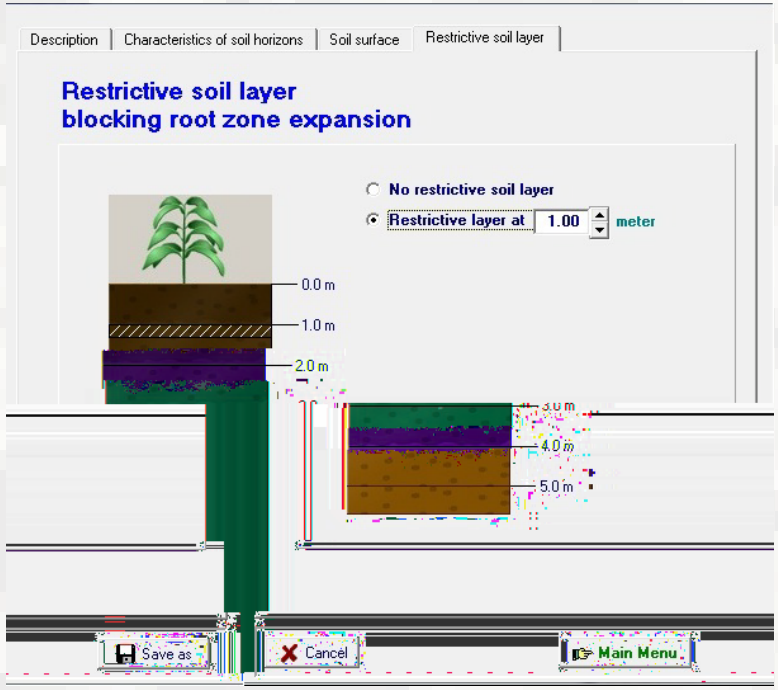




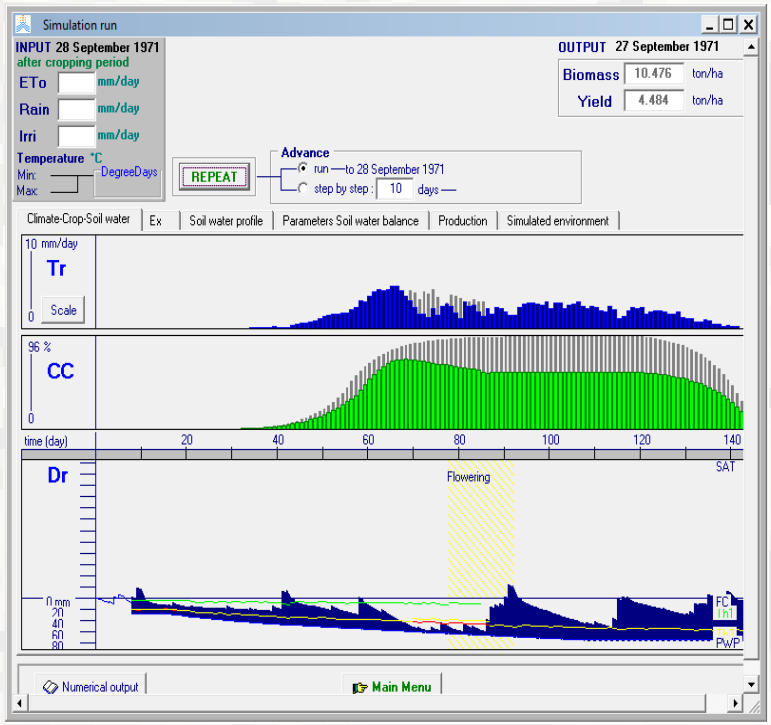
[redacted]

AquaCrop Inputs: Soil Profile Characteristics





AquaCrop Outputs



Objectives

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

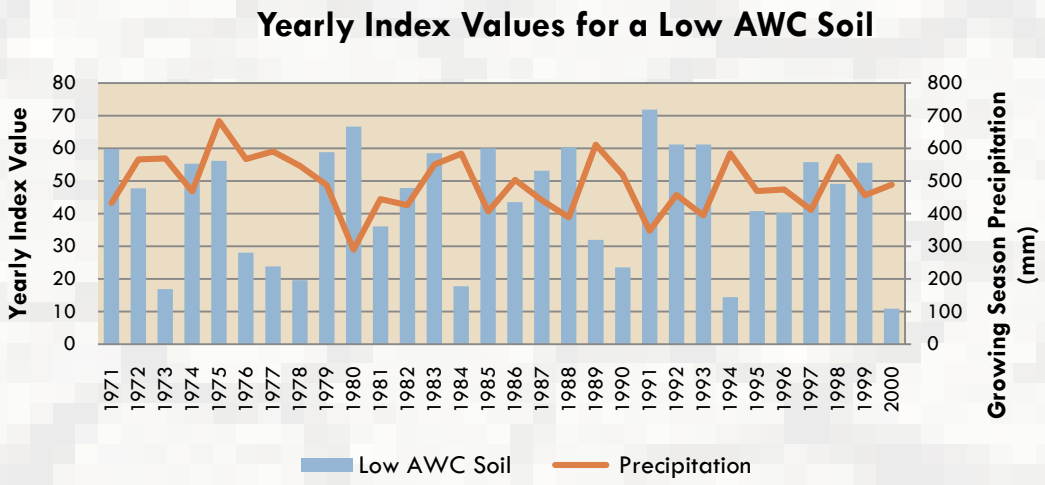
  Yield Formation stage: 0.5

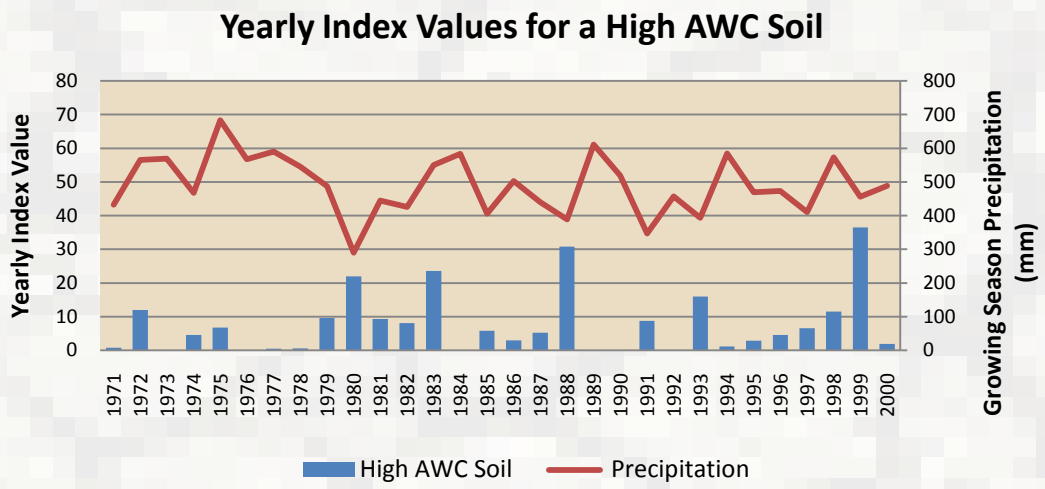
  (Doorenbos and Kassam, 1979)

Calculate Seasonal Water Stress Index:

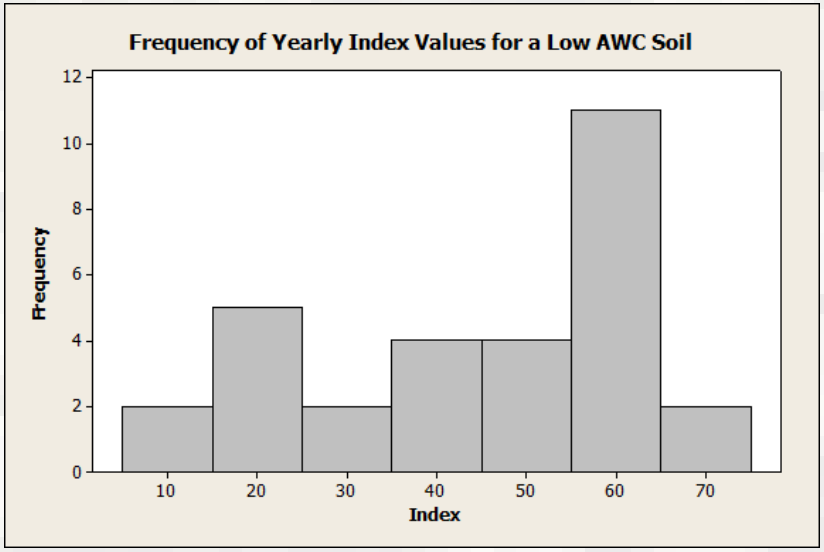
$$= \sum_{i=1}^{n} (W_i)(S_{D_i})$$ (Timlin et al., 1986)

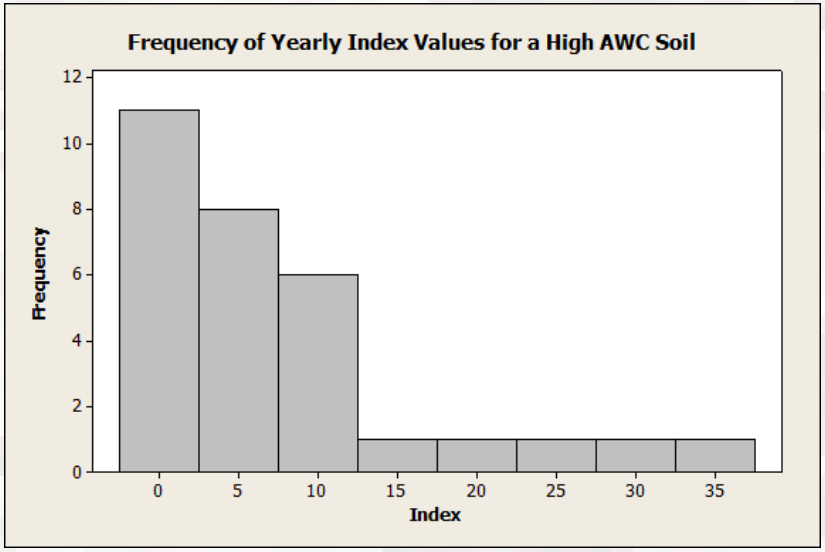
Preliminary Results



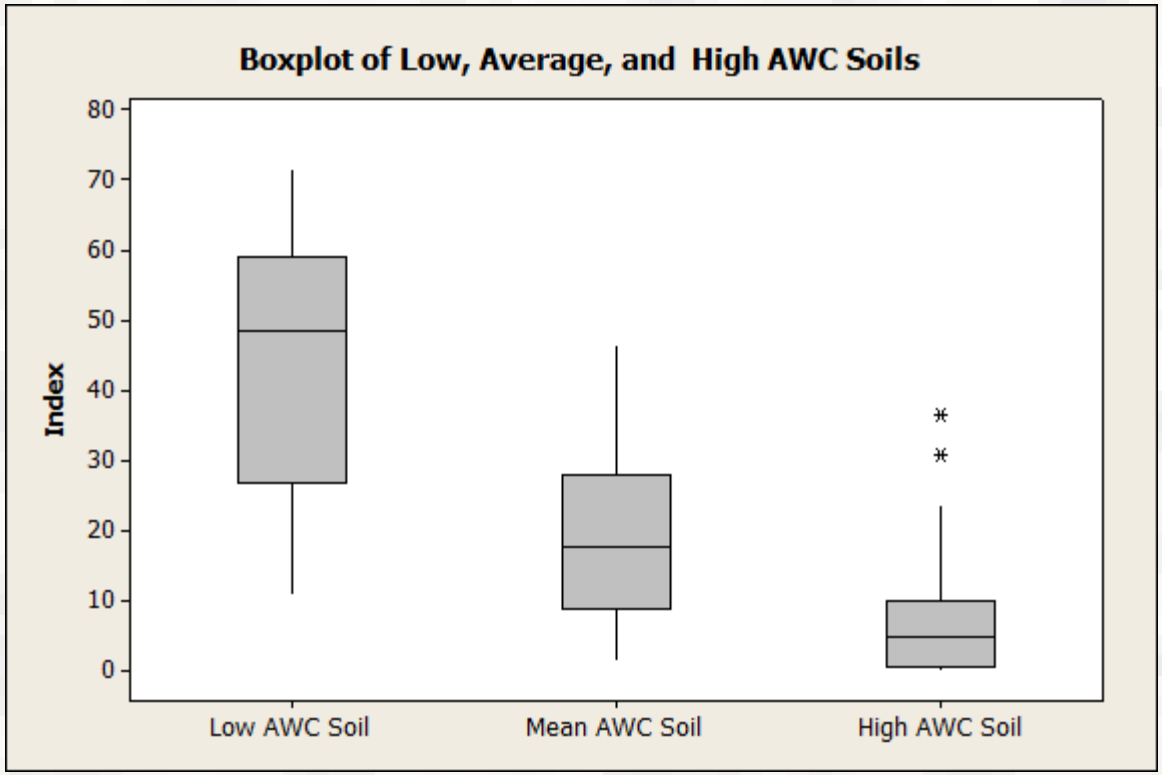


Preliminary Results





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 Acknowledement

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