DEPARTMENT OF ENVIRONMENTAL SCIENCE & TECHNOLOGY

Soil Conservation Practices as Climate Change Adaptations in Eastern U.S. Crop Production: A Modeling Study

USDA United States Department of Agriculture CLIMATE HUBS

SARE Sustainable Agriculture Research & Education

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Research Questions

1. How will climate change affect corn and soybean production in the Eastern US?
2. Will no tillage and cover cropping serve as climate change adaptations in Eastern US corn and soybean production?

Research Farms

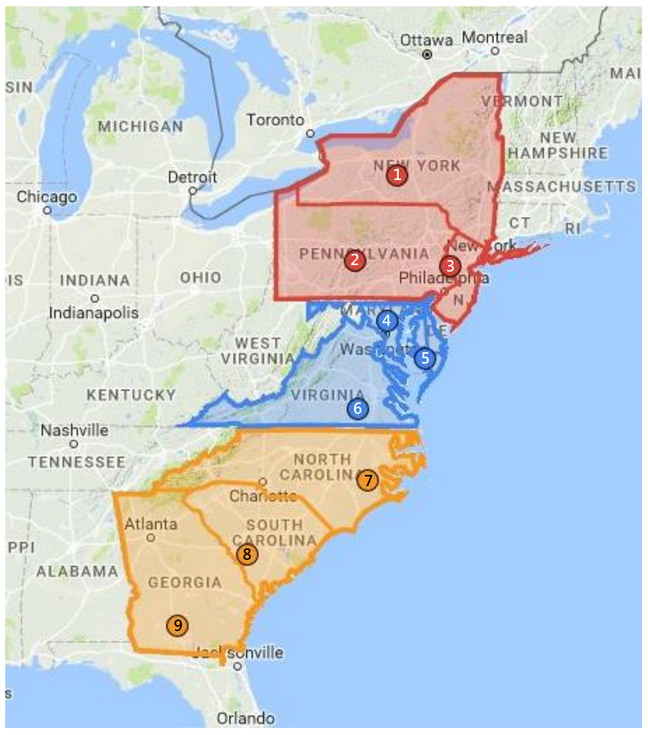


Figure 1. Land grant university research farms used in this study (Google My Maps)

North region

1. Musgrave Research Farm, Aurora, NY
2. Snyder Research & Extension Farm, Pittstown, NJ
3. Russel E. Larson Agricultural Research Center, Pennsylvania Furnace, PA

Central region

4. Central Maryland Research & Education Center, Clarksville, MD (MD1)
5. Lower Eastern Shore Research & Education Center, Quantico MD (MD2)
6. Southern Piedmont Agricultural Research & Extension Center, Blackstone, VA

South region

7. Lower Coastal Plain Tobacco Research Station, Kinston, NC
8. Edisto Research & Education Center, Blackville, SC
9. University of Georgia Tifton Agricultural Experiment Station, Tifton, GA

Research Objectives

1. To validate the Agricultural Policy/Environmental eXtender (APEX) model for corn and soybean yields in our study region.
2. To model the effects of climate change on crop yields, soil quality, and nutrient losses in corn-soybean rotations (under conventional tillage and no cover crop use).
3. To model the effects of no tillage and cover cropping in the future on crop yields, soil quality, and nutrient losses in corn-soybean rotations.

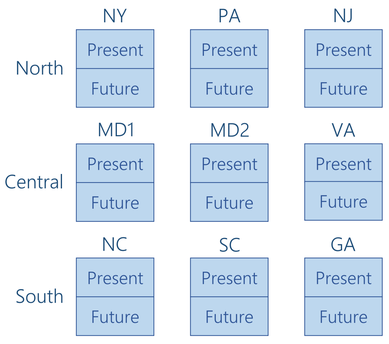
Methods

Objective 1: Validation *(completed)*

1. Gathered crop yield, soil, and field management data from the corn and soybean variety trials carried out at four of the research farms (Table 1). Gathered weather data from weather stations on the farm or nearby.
2. Used APEX to simulate the corn and soybean variety trials in these four farms and compared the simulated yields with the observed ones.
3. Adjusted APEX parameters (nitrogen fixation and water stress) in order to minimize the differences between simulated and observed yields.

Objective 2: Climate change impacts *(to be completed)*

1. Simulate a corn-soybean rotation (conventionally-tilled and without cover crops) at each farm in the present (1971-2000) and future (2041-2070).
2. Carry out these simulations once under each of four different future climate regional model predictions.
3. Analyze crop yields, soil organic carbon, nitrogen and phosphorus losses, and soil erosion outputs separately for each future climate.



Experimental design: Split plot design

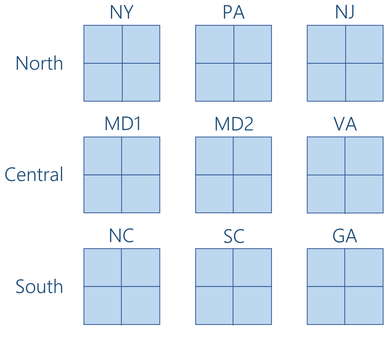
Factors of interest:

a. Main plot factor: Region
   - 3 levels (North, Central, and South) replicated 3 times
   - 9 main plots (farms)
b. Sub-plot factor: Time
   - 2 levels (present and future) replicated 9 times
   - 18 sub-plots

Figure 2. Experimental design that will be used to complete objective 2.

Objective 3: Climate change adaptations *(to be completed)*

1. Simulate a corn-soybean rotation in the future (2041-2070) at each farm under each of four different treatments:
   a. Conventional tillage, no cover crop
   b. Conventional tillage, cover crop after each main crop
   c. No tillage, no cover crop
   d. No tillage, cover crop after each main crop
2. Carry out these simulations once under each of four different future climate regional model predictions.
3. Analyze crop yields, soil organic carbon, nitrogen and phosphorus losses, and soil erosion outputs separately for each future climate.



Experimental design: Split plot design

Factors of interest:

a. Main plot factor: Region
   - 3 levels, replicated 3 times
   - 9 main plots (farms)
b. Sub-plot factor: Tillage x cover cropping
   - 4 levels, replicated 9 times
   - 36 main plots

Figure 3. Experimental design that will be used to complete objective 3.

Validation Results

Table 1. Absolute differences (%) between simulated and observed corn and soybean yields: average difference in single-year yields and difference in multi-year average yields.

	Corn		Soybeans	
	Single-year	Multi-year avg.	Single-year	Multi-year avg.
PA	19.0	6.0	21.3	19.2
MD2	20.1	7.8	21.2	0.6
NC	21.2	14.5	27.2	14
GA	12.5	3.2	21.5	3.8
Average	18.2	7.9	22.8	9.4

Note: Observed yields that were more than two standard deviations from the mean were not used in these calculations.

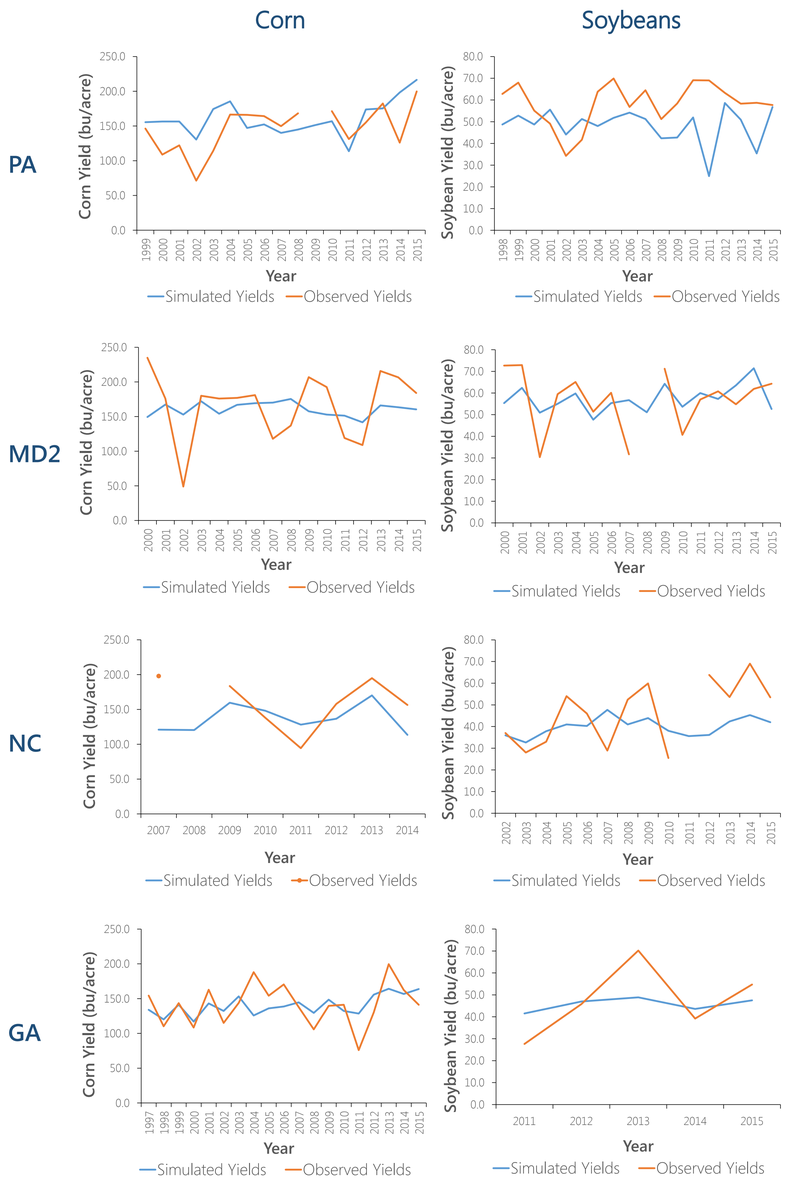


Figure 4. Yearly simulated and observed corn and soybean yields.

Validation Conclusions

1. APEX is simulating multi-year average corn and soybean yields with an acceptable level of error (<10% on average) in our study region. It is moderately accurate when simulating single-year yields (~20% error).
2. Overall, APEX is underpredicting both single-year and multi-year average corn and soybean yields more than it is overpredicting them.