Introduction:

A Changing Landscape

Over the past decade the crop landscape of North Dakota has witnessed a large swing in acreage of corn, soybeans, and wheat driven by the individual farmer decision-making process. This has transpired into an increase in soybean and corn acreage by over 300% and a smaller decrease in wheat acreage over the same timeframe.

Simulation Models: Limitations in Landscape Modeling

To understand these changes more completely and to aid with future farmer decision-making, crop simulation models such as the Agricultural Land Management Alternative with Numerical Assessment Criteria (ALMANAC) model, are used to simulate crop growth. These models work at a point-scale basis, taking as inputs field managements, weather, and soil characteristics and simulating biomass growth and plant stage development. These are often taken into the future via coupling with global climate simulations. However, these models have the limitation of relying on static rotation scenarios, which inherently adds an unrealistic aspect to simulation models. In this study we add human factors to the crop planting decision logic to mimic real world decision-making at a localized scale across the entire Prairie Pothole Region of North Dakota.

Methodology:

To incorporate the decision-making process into the ALMANAC crop simulation model we combined a economic model with the crop simulations at a annual timestep as follows:

1. Weather (NARR)
2. Soil (SSURGO)
3. Policy
4. Markets
5. Management
6. Crop (COIL)
7. Crop (COIL) Multi-Year Simulation (ALMANAC)
8. Crop Yield

Results:

When comparing to the standard historic rotation based system overall the following results were found:

- **Acreage estimations** of corn and soybean were improved by 13% and 11% respectively.
- However, wheat plantings saw little improvement
- Adjustments were made to account for non-agricultural land and non-study crops.
- **Yield predictions** for corn were improved by 14% for the study area due to the proper simulation of the location of the fields.
- **Soil health** change was simulated and noted, but no definitive results were found.

Tools and Datasets

- **Crop Simulation Model**: For the crop simulations the ALMANAC crop model was used, this simulates crop growth at a daily step size for a point based location.
- **Economic Model**: To add local level decision-making a spatially-explicit land-use model was incorporated directly into the decision making logic of the crop model management.
- **Soils**: The Soil Survey Geographic Database (SSURGO) was used for soil profile information.
- **Weather**: The North American Regional Reanalysis (NARR) was utilized, daily timestep for local weather conditions.
- **Crop History**: For historic crop locations and crop calibration the Cropland Data Layer was used.

The study was broken into two regimes to determine planting acreage and locations:

- **Historic Approach**: Using the historic crop information from 2001-2013 acreage and location of each planted crop was selected by the percentage each crop had been seen historically by soil type.
- **Coupled Economic Model Approach**: The economic model was given 2013 yield data from ALMANAC and setup to mimic conditions going into the 2014 growing season. The economic model provided crop probabilities which were then used to select the most probable by soil type.

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