Introduction

- In Tennessee, the most grown crops are cotton, corn, soybeans as well as wheat.

- It is important for farmers to determine which crops to grow for the next year.
Because of the uncertainty of soil condition and weather condition, it is hard to estimate the total yield of the crop for the next year.

It will help to make decision of which crop to grow if the farmers can know some information about crop yields.

Simulation is particularly valuable when there is significant uncertainty regarding the outcome or consequences of a particular alternative under consideration.
One of the computer-based simulation model-ALMANAC- will be used in this study.

The ALMANAC model can help to simulate the yields of some kinds of crops, as well as the biomass generated by that crop.

Biomass
- Biomass refers to living and recently dead biological material that can be used as fuel or for industrial production.
- Most commonly, biomass refers to plant matter grown for use as biofuel.

In this study, we will consider to grow corn, soybean, and wheat on Dunmore and Dewey soil in Monroe county in Tennessee.
Objectives

- The objectives of this study are:
  - Simulate the crops yield using ALMANAC model, and get the possible distribution of the yield
  - Based on the simulation results, use decision tree method to decide which crop to grow
  - Also, consider about the biomass that can be generated by growing corn and wheat, add them to the decision tree to make the final decision more accurate

Methodology

- Model description
  - The ALMANAC (Agricultural Land Management Alternative with Numerical Assessment Criteria)
  - In order to improve crops simulation by ALMANAC, some data such as operation dates, fertilizers applied, and crop densities are used to simulate the yield

- Soil Type: Dunmore and Dewey

- Weather
  - Weather data from Athens Weather Station
    - (LATT = 35.43, LONG = 84.58)

- Crops:
  - Corn
  - Soybean
  - Wheat
Input data for ALMANAC

<table>
<thead>
<tr>
<th>Crop</th>
<th>Density (plants/m²)</th>
<th>Fertilizer date</th>
<th>N</th>
<th>P2O5</th>
<th>K2O</th>
<th>Plant date</th>
<th>Harvest date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>6</td>
<td>(422)</td>
<td>190.4</td>
<td>71.4</td>
<td>78.4</td>
<td>(5/11)</td>
<td>(10/1)</td>
</tr>
<tr>
<td>Soybeans</td>
<td>32</td>
<td>(5/7)</td>
<td>0</td>
<td>22.4</td>
<td>44.8</td>
<td>(5/15)</td>
<td>(10/1)</td>
</tr>
<tr>
<td>Wheat</td>
<td>60</td>
<td>(922)</td>
<td>88.6</td>
<td>64.8</td>
<td>22.4</td>
<td>(10/1)</td>
<td>(06/13)</td>
</tr>
</tbody>
</table>

Extended Pearson-Tukey Method
- Three-point approximation using:
  - The median value
  - The 5th percentile (0.05 fractile) value
  - The 95th percentile (0.95 fractile) value

\[ E(x) = \sum x \cdot p \]
Decision Tree
- Comprehensive tool for modeling all possible decision options
- All options, outcomes and consequences, along with the values and probabilities associated with them are shown directly

Data
- We need to calculate the profit of growing one kind of the crop
- Historical prices for each crop
- Average costs for each crop (variable costs)
  - Fertilizer
  - Labor
  - Machine

\[ \pi = \sum \text{price} \times \text{yield} - \sum \text{cost} \times \text{yield} \]

Preliminary Results

<table>
<thead>
<tr>
<th></th>
<th>Continuous Soybean</th>
<th>Continuous Corn Grain</th>
<th>Continuous Wheat Grain</th>
<th>Continuous Wheat Stover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (bu/acre)</td>
<td>Mean</td>
<td>50.41</td>
<td>160.79</td>
<td>5.13</td>
</tr>
<tr>
<td></td>
<td>Std Dev</td>
<td>3.31</td>
<td>8.86</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>Min</td>
<td>42.88</td>
<td>134.94</td>
<td>4.33</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>57.10</td>
<td>180.67</td>
<td>5.76</td>
</tr>
</tbody>
</table>
Fitted Distribution of Soybean yield, Dunmore soil

(Median = 50.407)

Yield Results for Dewey Soil (no till)

<table>
<thead>
<tr>
<th></th>
<th>Continuous Soybean</th>
<th>Continuous Corn Grain</th>
<th>Continuous Wheat Grain</th>
<th>Continuous Wheat Straw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>50.22</td>
<td>160.22</td>
<td>5.11</td>
<td>53.89</td>
</tr>
<tr>
<td>Std Dev</td>
<td>3.60</td>
<td>9.14</td>
<td>0.29</td>
<td>7.81</td>
</tr>
<tr>
<td>Min</td>
<td>37.03</td>
<td>131.91</td>
<td>4.21</td>
<td>37.17</td>
</tr>
<tr>
<td>Max</td>
<td>57.10</td>
<td>180.98</td>
<td>5.78</td>
<td>73.46</td>
</tr>
</tbody>
</table>

Fitted Distribution of Soybean yield, Dewey soil

(Median = 50.2811)
Further Study

- Find the appropriate prices for the crops and biomass, costs for grow each crop to generate the profits of each crop
- Develop decision trees to determine which crop is more profitable to grow, and the how much risk it will take to grow the crop

Acknowledgement

- Dr. Burton English
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Questions?