Farm Decision-making: Simulation and Decision Tree Approach

Wen Tu
PhD Candidate
University of Tennessee-Knoxville
Department of Agricultural Economics

Content

- Introduction
- Objectives
- Methodology
- Preliminary Results
- Further Study

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

Tennessee Data - Sorghum
Planted, Harvested, Yield

Commodity	Year	State	Planted All Purposes	Harvested	Yield
Sorghum For Grain	2001	Tennessee	25 thousand acres	22 thousand acres	80 bushel
Sorghum For Grain	2002	Tennessee	30 thousand acres	26 thousand acres	80 bushel
Sorghum For Grain	2003	Tennessee	45 thousand acres	40 thousand acres	82 bushel
Sorghum For Grain	2004	Tennessee	20 thousand acres	17 thousand acres	90 bushel
Sorghum For Grain	2005	Tennessee	22 thousand acres	20 thousand acres	92 bushel
Sorghum For Grain	2006	Tennessee	14 thousand acres	11 thousand acres	95 bushel
Sorghum For Grain	2007	Tennessee	22 thousand acres	19 thousand acres	70 bushel

- 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

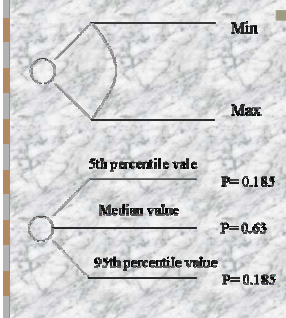
- Model description
  - The ALMANAC (Agricultural Land Management Alternative with Numerical Assessment Criteria)
  - In order to improve crops simulation by ALMANAC, some data such as operation dates, fertilizers applied, and crop densities are used to simulate the yield

- Soil Type:
  - Dunmore and Dewey
- Weather
  - Weather date from Athens Weather Station (LATT = 35.43, LONG = 84.58)
- Crops:
  - Corn
  - Soybean
  - Wheat

Input data for ALMANAC

	Crop Density (plants/m2)	fertilizer date	N	P2O5	K2O	Plant Date	Harvest Date
			kg/ha	kg/ha	kg/ha		
Corn	6	(4/22)	190.4	78.4	78.4	(5/1)	(10/1)
Soybeans	32	(5/7)	0	22.4	44.8	(5/15)	(10/1)
Wheat	400	(9/22)	89.6	44.8	22.4	(10/1)	(6/15)

- 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



- The median gets probability 0.63, and the 5th and 95th percentiles each have 0.185

$$E(x) = \sum x * p$$

- 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

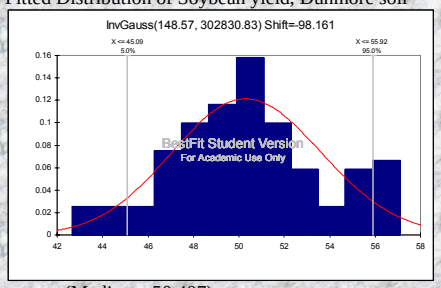
$\pi = \sum \text{price} * \text{yield} - \sum \text{cost} * \text{yield}$

Preliminary Results

Yield Results for Dunmore Soil (no till)

	Continuous Soybean	Continuous Corn		Continuous Wheat	
		Grain	Stover	Grain	Straw
	bu/acre	bu/acre	tons/acre	bu/acre	tons/acre
Mean	50.41	160.79	5.13	53.98	3.00
Std Dev	3.31	8.86	0.28	8.74	0.53
Min	42.68	134.94	4.33	38.22	2.03
Max	57.10	180.67	5.76	72.42	4.42

Fitted Distribution of Soybean yield, Dunmore soil

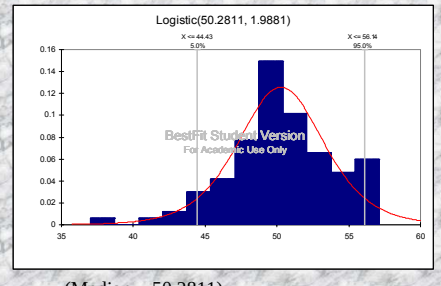


(Median = 50.407)

Yield Results for Dewey Soil (no till)

	Continuous Soybean	Continuous Corn		Continuous Wheat	
		Grain	Stover	Grain	Straw
	bu/acre	bu/acre	tons/acre	bu/acre	tons/acre
Mean	50.22	160.22	5.11	53.89	2.97
Std Dev	3.60	9.14	0.29	7.81	0.57
Min	37.03	131.91	4.21	37.17	1.98
Max	57.10	180.98	5.78	73.46	4.56

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
- Dr. Lixia He

Questions?