Economic Analysis of Sequestration Options for Growers

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California Energy Commission, Third Annual Climate Change Conference

Sacramento September 13-15

Economic Methods

- Farmer response to payments is measured by combining economic survey and agronomic model predictions
- Crop and soil types determine the sequestration
- We estimate the farmer response for the sample farms by crop and soil type
- Use the cropping and soil data from Yolo Co to extrapolate the sample results to the county level.
- The aggregate carbon supply response show the level of sequestration by levels of payments

Measuring Farmer Response

- Farmers Respond to Economic incentives
- Costs of Sequestration practices may be reduced yields, or increased costs.
- The costs of measuring carbon directly are excessive thus farmers have to be paid by practice
- Two key questions
  - How will farmers respond to payments to adopt different practices ?
  - How will the new practices map into carbon sequestered ?

Data Sources for Farmer Economic Response

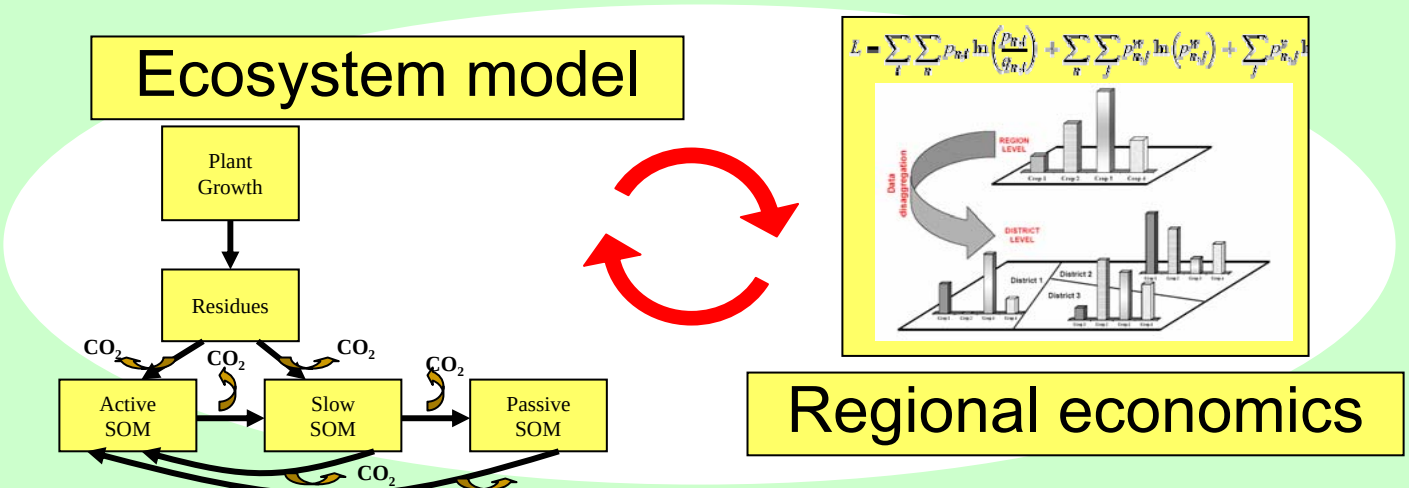
- Primary survey of farmers- adoption and conventional growers
- Experimental plot yields and costs
- County Commissioner Survey data over time
- DWR county land use surveys
- Crop growth model yield changes
- Individual farmer economic response models
- Scale up individual responses to the County level

Integrated modeling approach

Field experiments

Land use and management identification

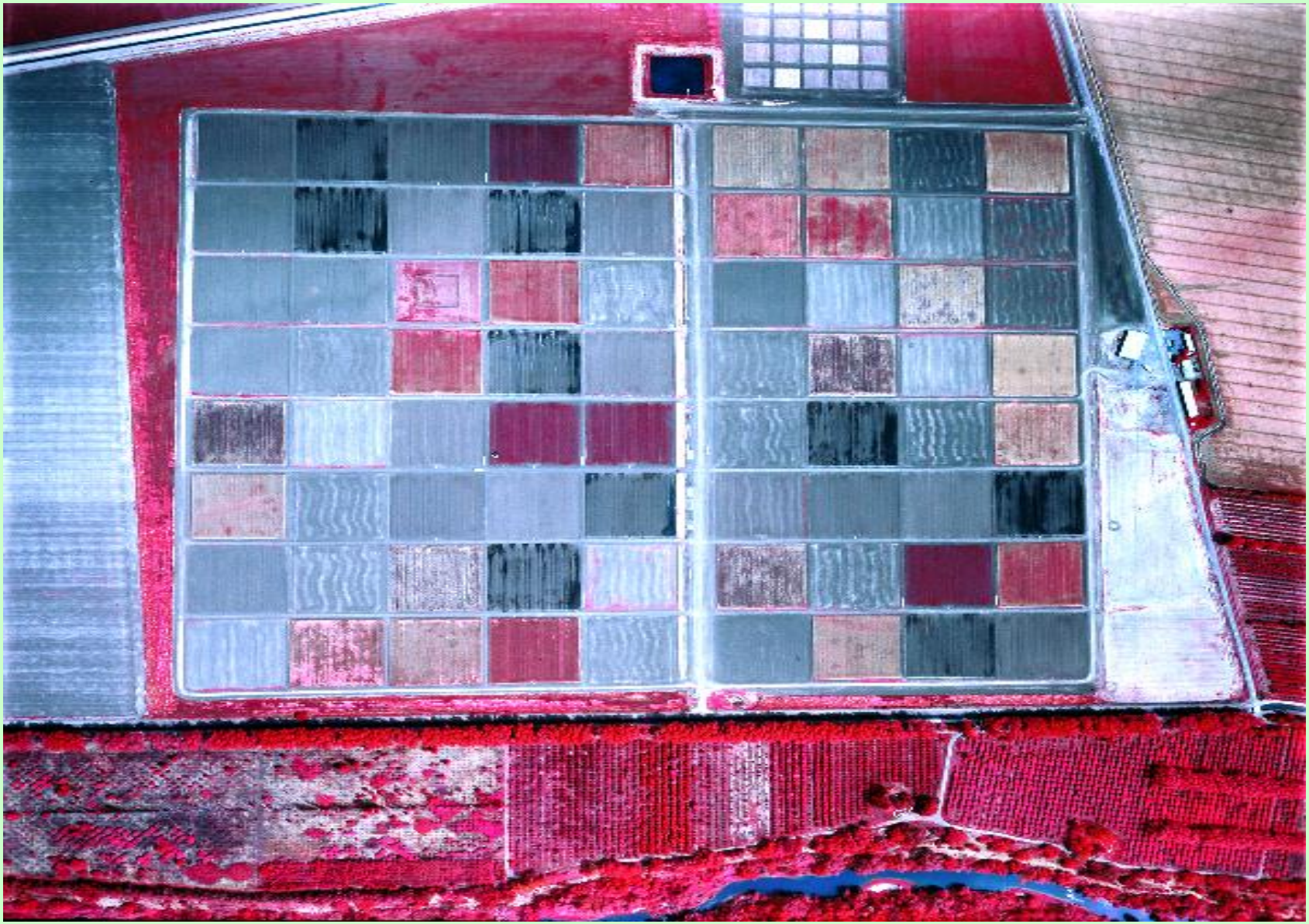
Spatial Information



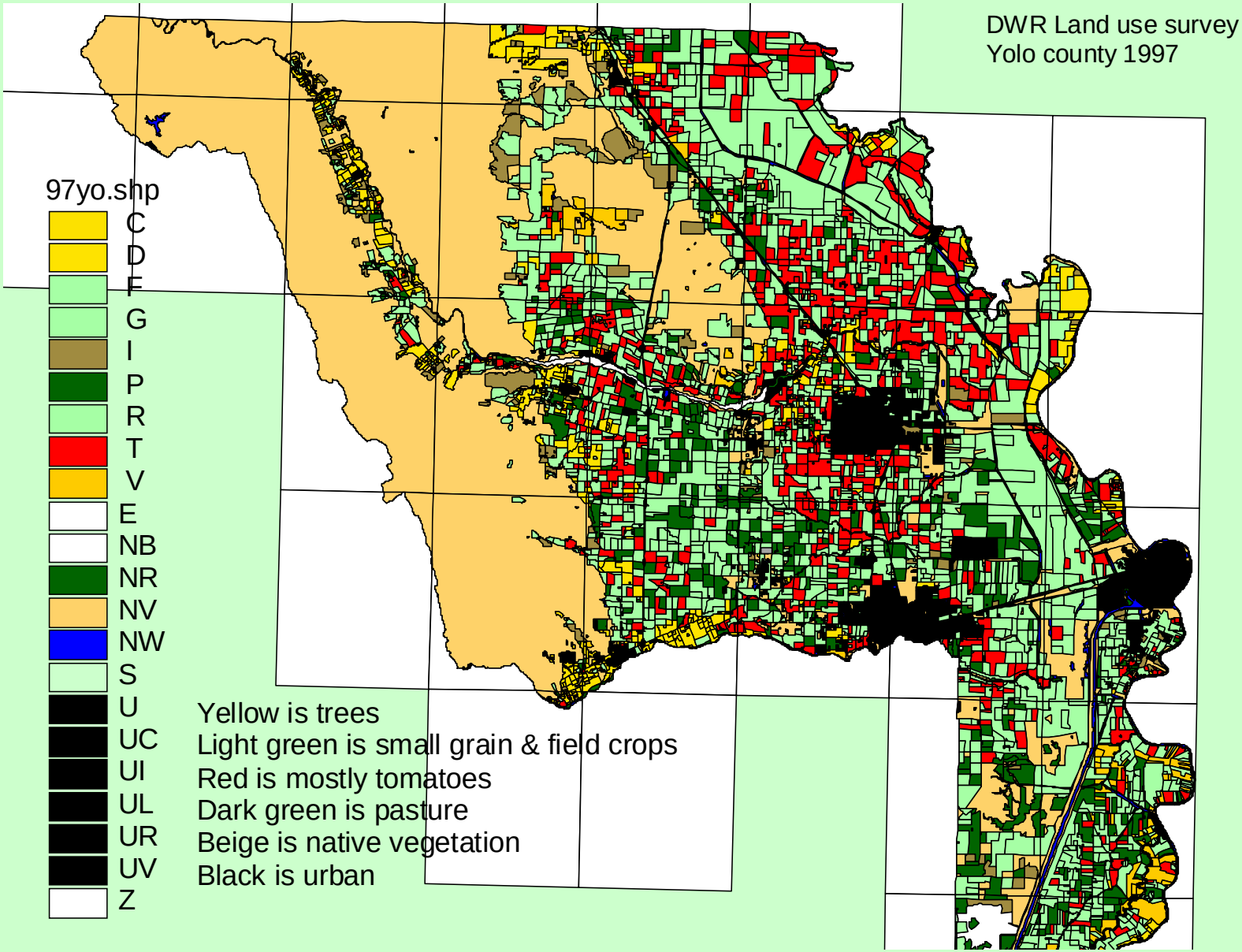
Decision support

With uncertainty estimates

Experimental Plot Level



Regional Land Use- Yolo- 1997



Farmers' choices

- **What** to grow and H**ow** to grow it

- Main Yolo Crops:
  - **Wheat** (21.1%),
  - **Tomato** (15.6%),
  - **Corn** (12.4%),
  - **Alfalfa** (9.71%).
  - **Sunflower** and **Safflower** (lower acreage),

- 4 Managerial practices:
  - **Conventional** (C),
  - **Organic** (O),
  - **Conservation/Reduced Tillage** (CT)
  - **Cover Cropping** (CC)

- Potentially 24 options
  - Number of observed combinations is a lot less than 24

Generating a Regional Carbon Sequestration Supply Response

- The regional carbon sequestration supply is the sum of the individual fields.

  Field carbon storage depends on crop & management.

  – We have to model the farmer choices
  – Farmers differ in their soils, micro climate, water source and price expectations on crops and inputs.

- Farmers have different preferences and skills on how to manage their fields.
  – We mostly observe a population using Conventional methods.
  – The economic reward for switching methods to ORG, CC, or CT is currently low.

- Economic and statistical analysis based on individual data can determine the distribution of those skills and preferences across a population of farmers in a region

Corn Stover- Conservation Tillage

The Current Farm Survey in Yolo

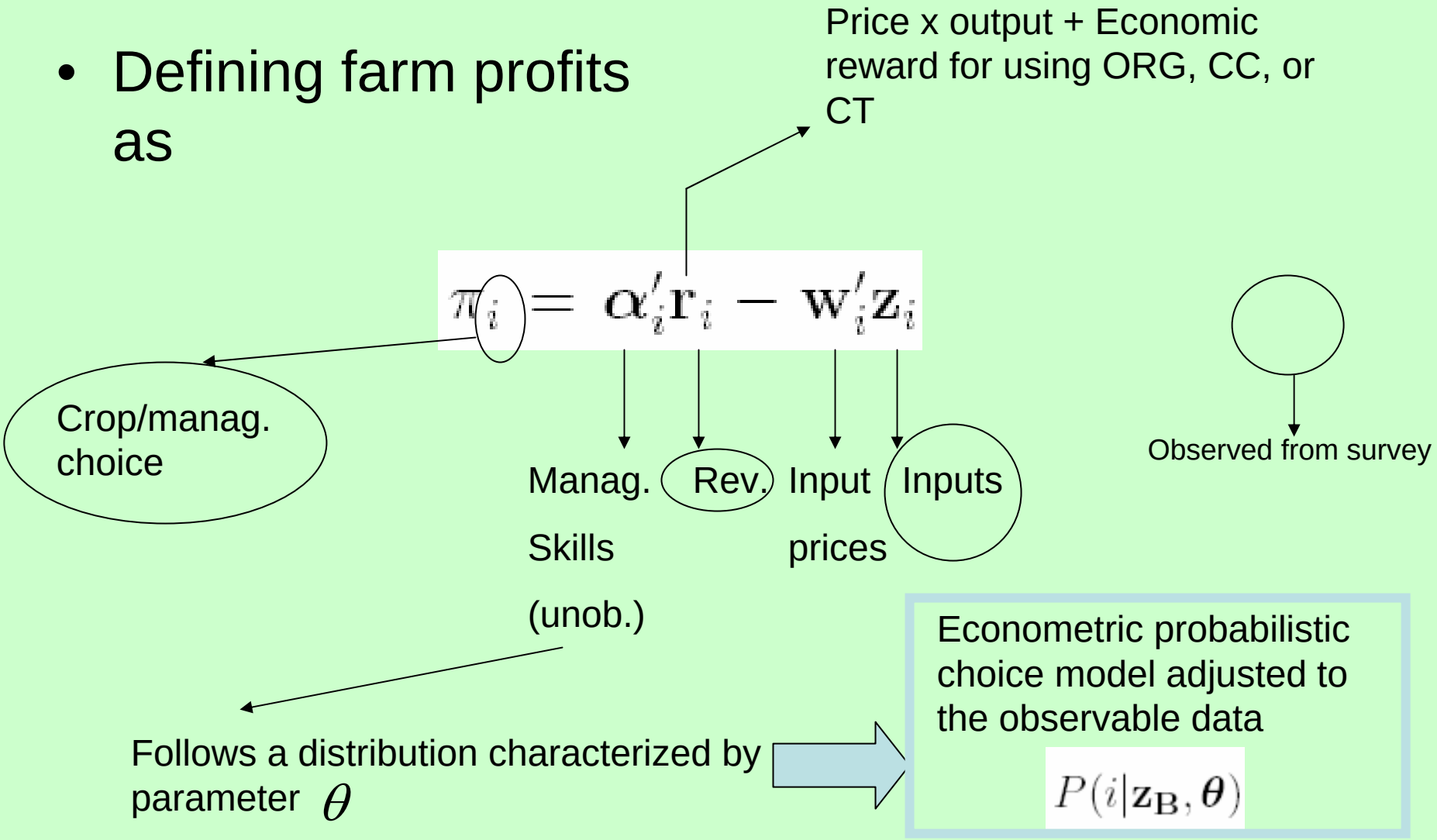
- To identify the distribution of farmers' behavior and to model their choices we needed information at the field level.
- A survey was designed to obtain information on 230 fields which were growing the 6 crops during 2005.
- The survey was stratified by crop and management technology.
- The survey is the main tool for implementing the integrated assessment (economics+agronomics)

Using the survey data

- The questionnaire yields data on the technology used on a particular field. It is used to:
- 1) Fit the agronomic-economic model to actual farmer decisions.
- 2) Reconstruct the economic costs associated to management and physical environment and to observe actual revenues
- 3) Estimate the distribution of management skills and preferences of farmers

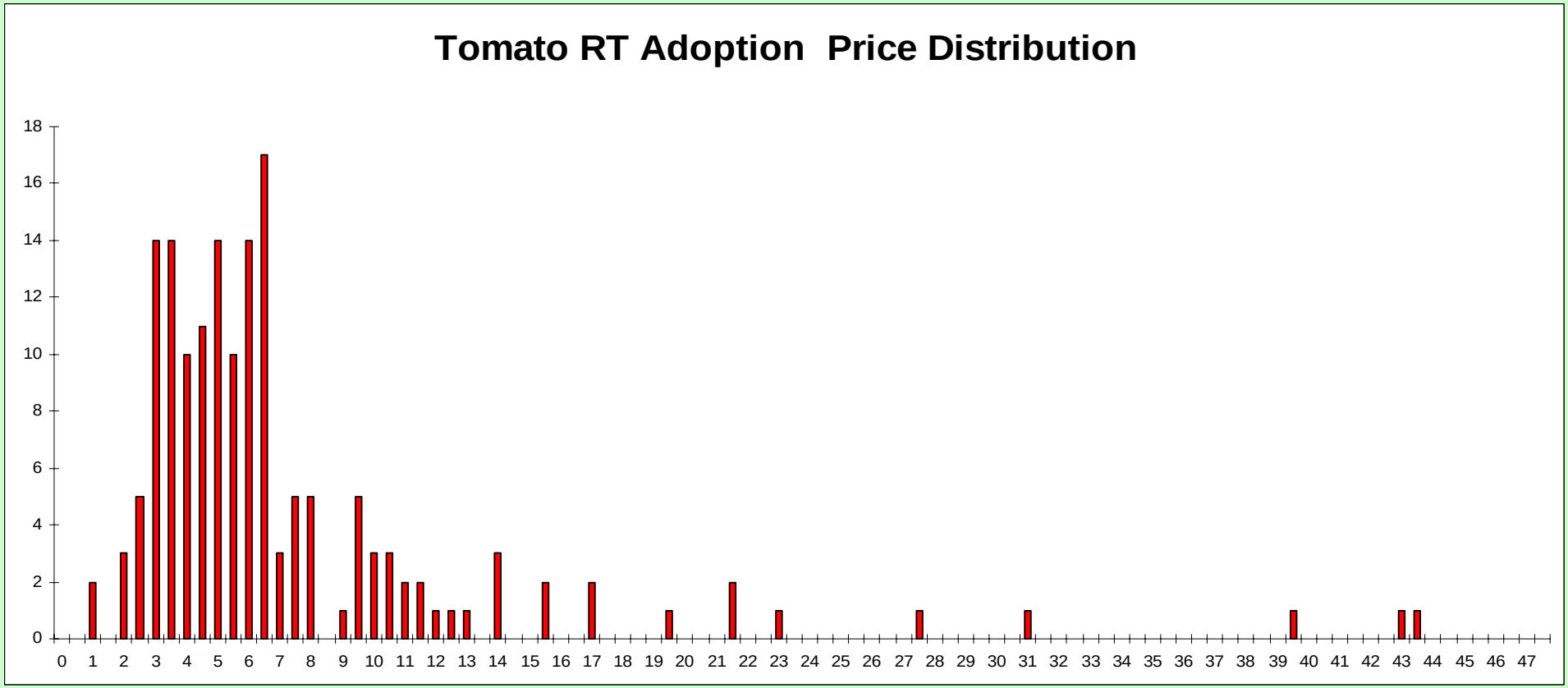
Modeling with the survey data

- Defining farm profits as



Integrated Assessment:Economics+Agronomy

- The probabilistic choice model:
  - Uses both the economics and the agronomy
  - Economic behavior of farmers changes from season to season
  - Depends on past crop/management and on price expectations.
- Farmers maximize profits accounting for
  - The biophysical environment
  - Expected prices of inputs and outputs
  - Economic payments for adoption of sequestration practices.


Tomato RT Adoption Price Distribution
0
2
4
6
8
10
12
14
16
18
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47

Productivity-Technology Elasticity

$$\frac{\%\Delta \text{ Adoption Probability}}{\%\Delta \text{ Productivity}}$$

	Conventional	Reduced	Organic
Wheat	0.48	1.6	0.96
Tomatoes	0.3	1.23	0.98
Corn	-0.47	2.6	0.97
Rice	0.36	1	0.95
Safflower	0.69	1.32	0.97
Sunflower	0.56	1.27	0.97

The Calculation of a Sequestration Price

$$Mitigation\ Price = \frac{\left(NPV_i - NPV_j\right) / Discount\ Factor}{Total\ Carbon\ Sequestration\ of\ \ Practice\ j\ over\ i\ in\ year\ t}$$

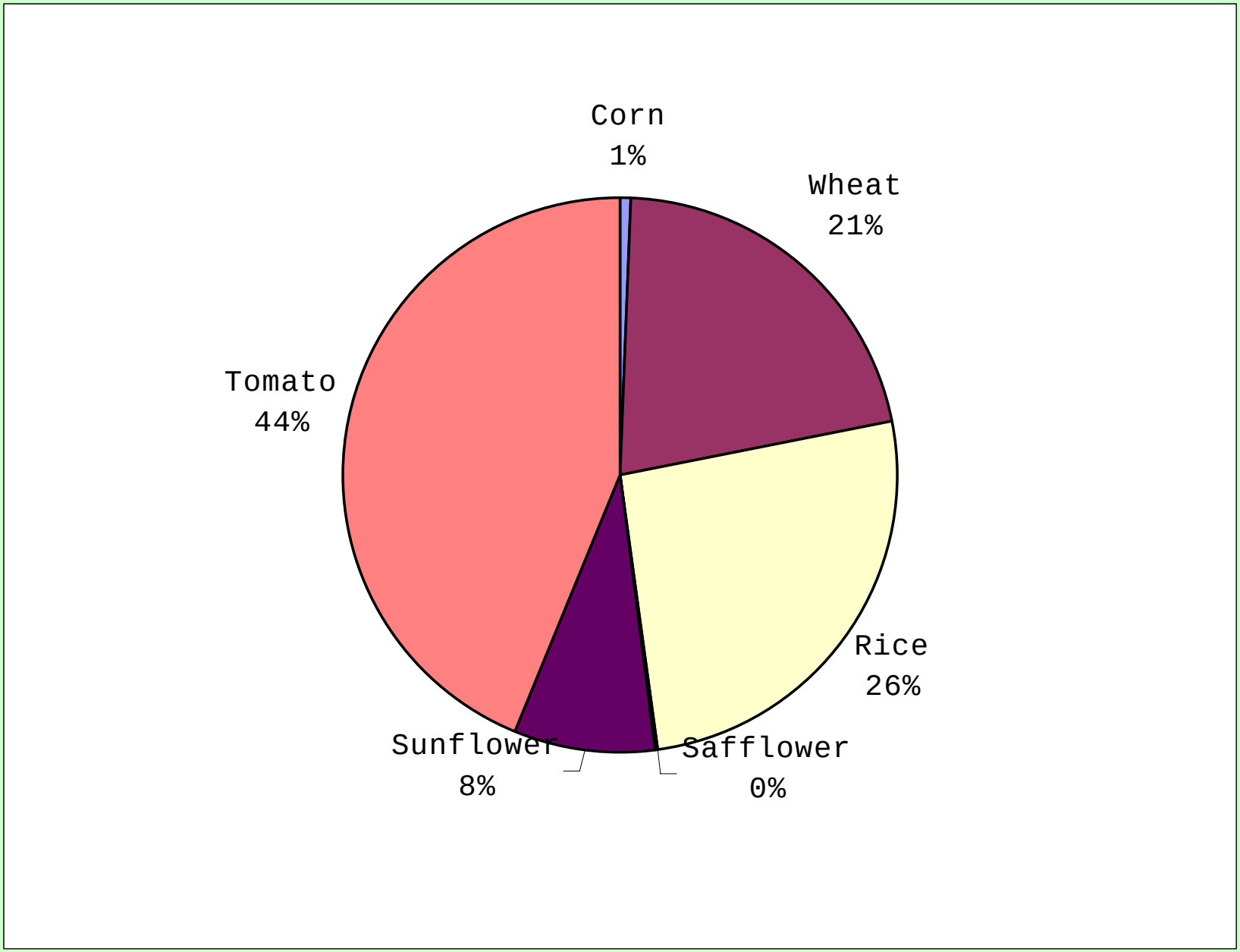
$i = Conventional\ Farming$

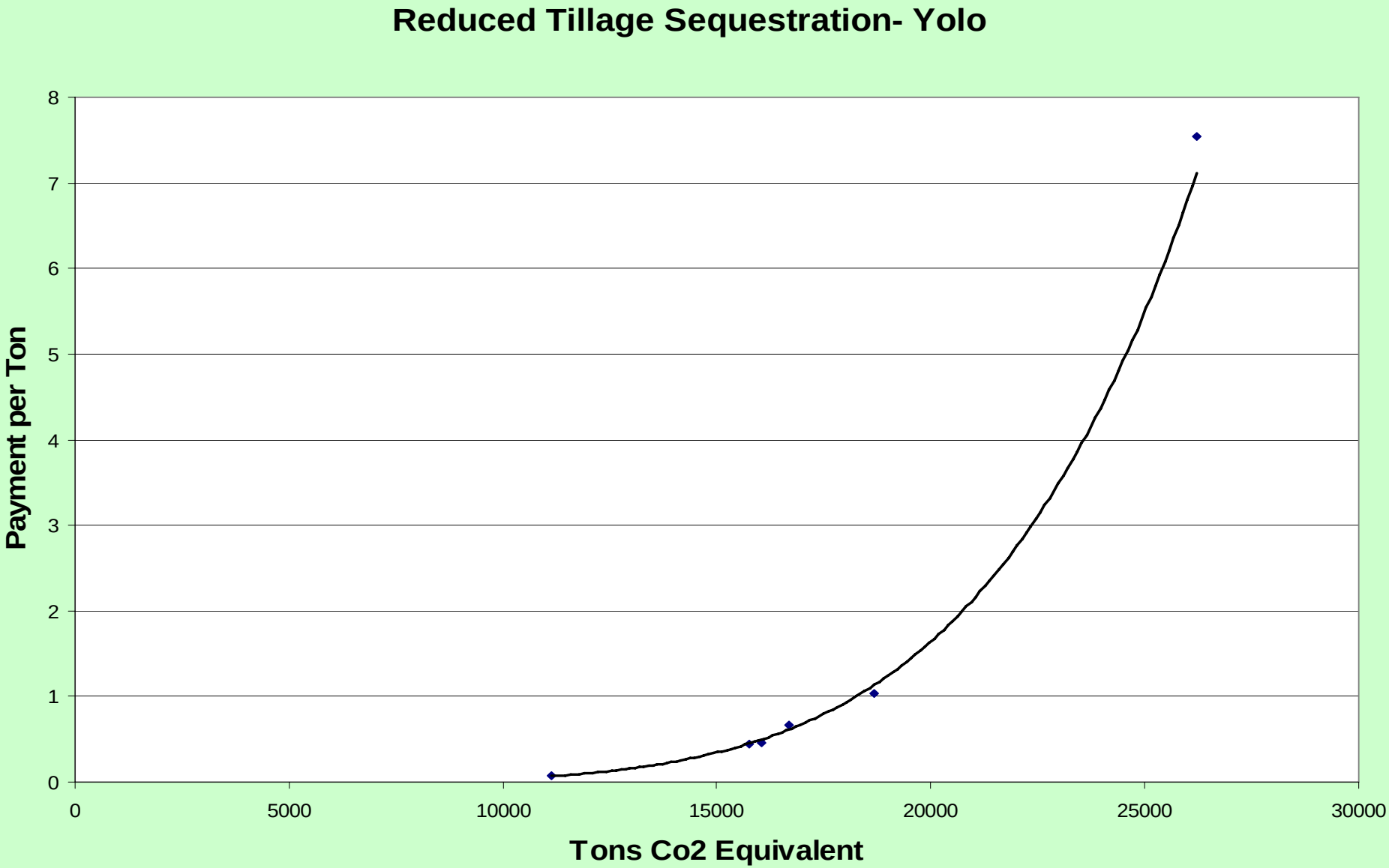
$j = Cover\ Crops,\ Conservation\ Tillage,\ Organic.$

Aggregation to Regional Sequestration

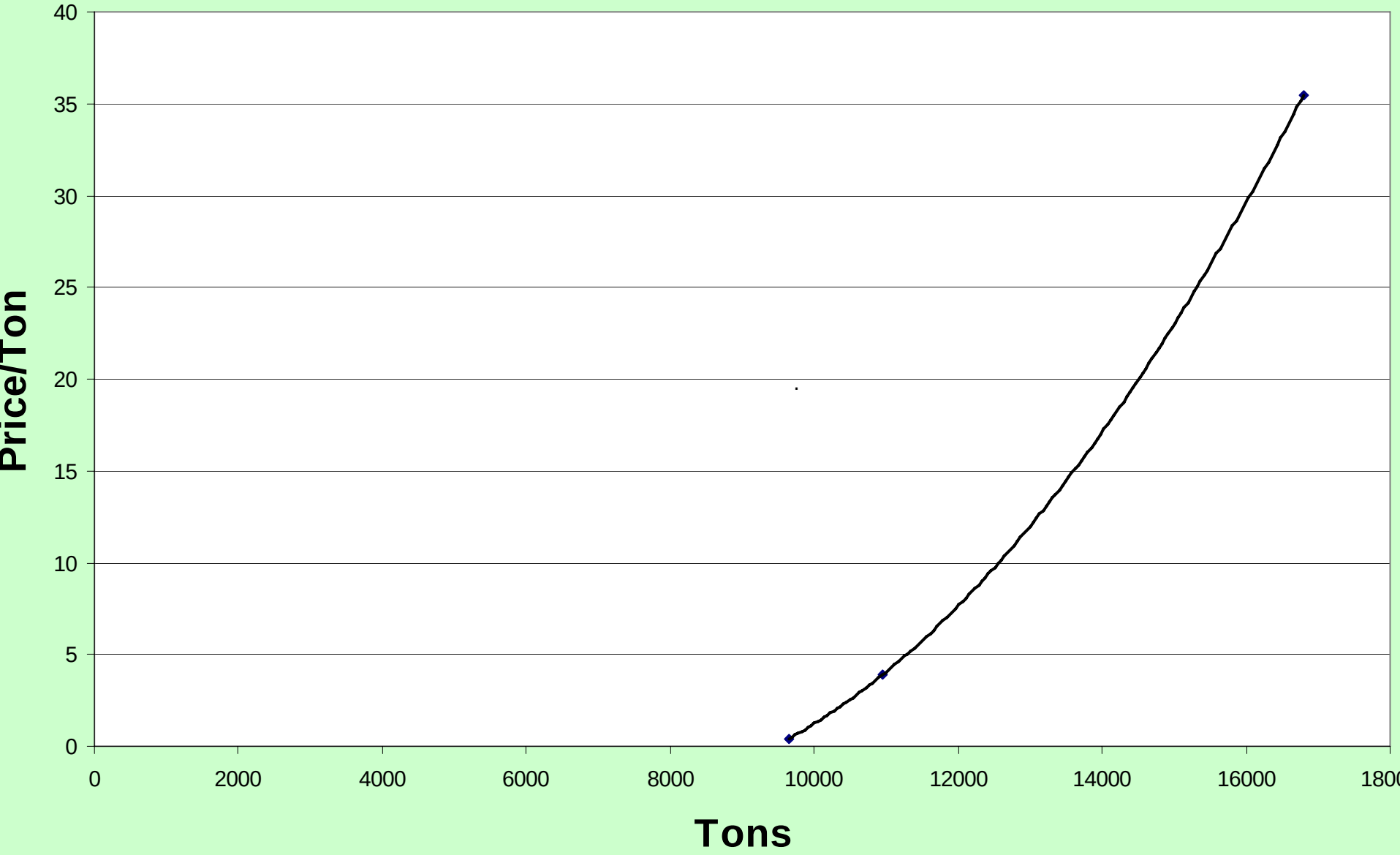
- Given a calibrated regional model, we simulate for different prices how many farmers would switch to RT, CC, MAN
- We then compute the additional carbon sequestered by each of those practices.
- We obtain the Carbon-Sequestration supply function for the region

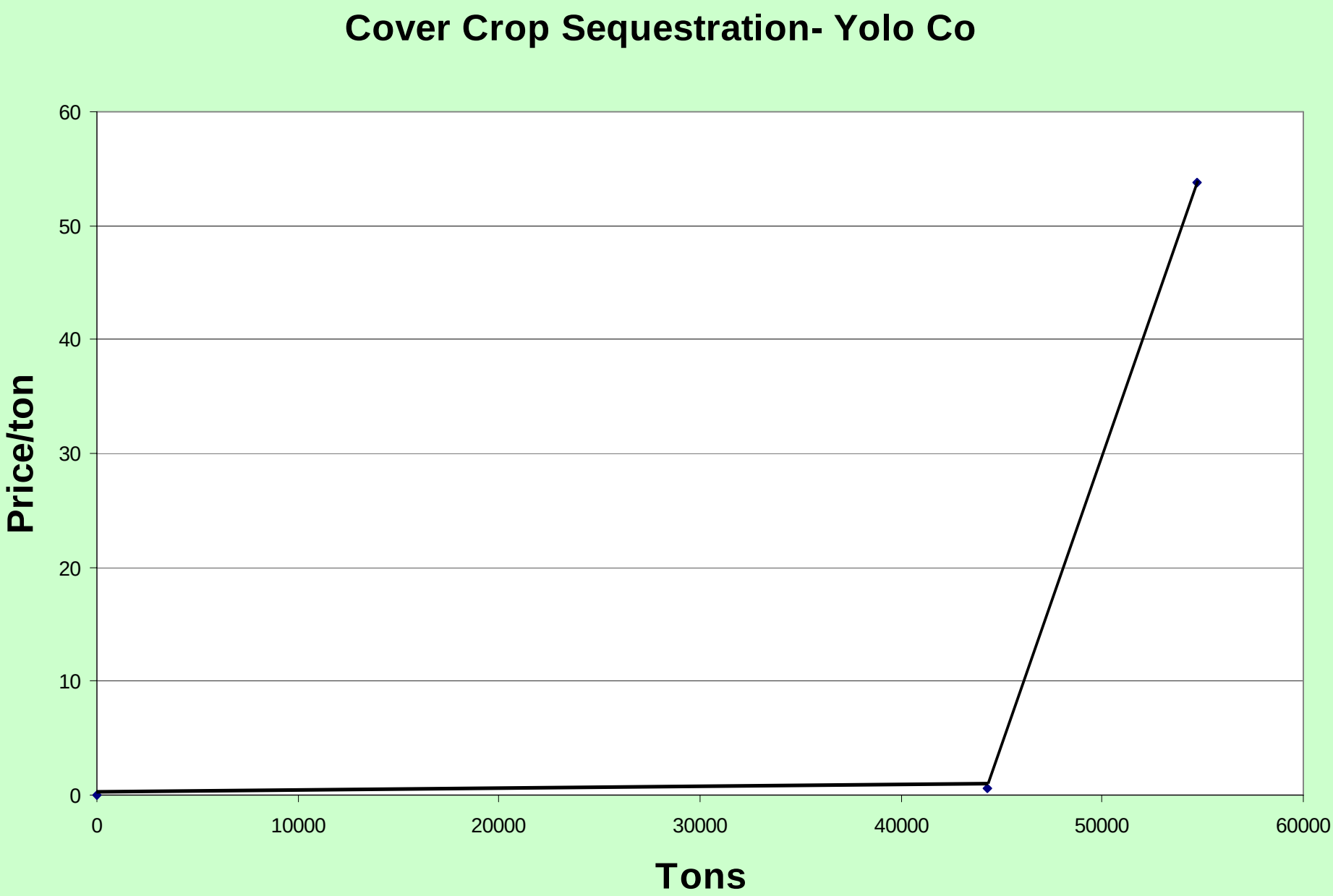
Reduced Tillage Sequestration: Crop Contribution




Reduced Tillage Sequestration- Yolo
Payment per Ton
0
1
2
3
4
5
6
7
8
0
5000
10000
15000
20000
25000
30000
Tons Co2 Equivalent

Reduced Tillage & Manure Sequestration- Yolo




Cover Crop Sequestration- Yolo Co
Price/ton
60
50
40
30
20
10
0
0
10000
20000
30000
40000
50000
60000
Tons

County Level Conclusions

- Farmers will change their crop technologies in response to sequestration payments
- Sequestration cost depends on soil and crop types
- Yolo county could sequester 33-39,000 tons of carbon by reduced tillage and manure in response to payments of $3-8/ ton/year
- This level of sequestration is approximately 3% of the county carbon release
- Cover cropping with Rice could double this sequestration.