Ex-ante Estimation of Adoption Determinants for a Sustainable Land Management Practice: The Case of Non-operator Landowners

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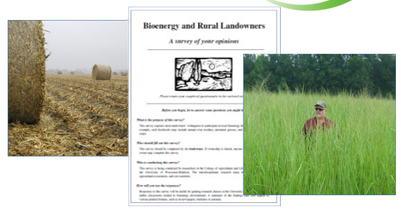


Introduction

In 2012, non-operator landowners controlled 30% of all U.S. land in farms. Yet, past literature on bioenergy crop adoption focuses on farm operators and tenants, often overlooking the role of non-operator landowners.

- These landowners do not operate any of the land they own but may rent out some or all of it to others (USDA TOTAL Survey).
- This research develops ex ante estimates of non-operators' willingness-to-accept (WTA) to supply corn stover and switchgrass.
- The analysis permits hypothesis tests regarding non-operator choice behavior.

Research Questions

We investigate research questions motivated by non-operator landowners' potentially different treatment of income and non-income factors in their land use decision-making behavior:

- Q1: Is land-based income a significant source of utility for non-operators? If so, does marginal utility vary by income level?
- Q2: What is non-operators' WTA to supply land for corn stover & switchgrass? How sensitive is it to previous rental experience?
- Q3: What is the effect of preferences for bioenergy & environmental quality on WTA?
- Q4: How does non-operators' WTA compare to that for operator landowners?

Conceptual Framework

Consider a non-operator landowner who must decide whether to supply land for corn stover or switchgrass for bioenergy:

- They supply land if utility with the new practice is at least as great as without it:

$$U_1(Y_1, \boldsymbol{Q_{1j}}, \boldsymbol{Z}, \varepsilon_1) - U_0(Y_0, \boldsymbol{Q_0}, \boldsymbol{Z}, \varepsilon_0) \geq 0$$

Where:

- $U_i(\cdot)$ = indirect utility function (where i = 1 with adoption, and i = 0 otherwise)
- Y_{ij} = net return to land management,
- $\boldsymbol{Q_{ij}}$ = a vector of non-income preference attributes,
- $\boldsymbol{Z_j}$ = a vector of household characteristics,
- ε_{0j} = a random component of preferences known only to the landowner

Empirical Application

Information on intentions to supply land for bioenergy land management practices come from a mail survey in southwestern Wisconsin:

- The target population consisted of private non-operator landowners.
- The sample included landowners with one or more parcels of ag or woodland in Iowa, La Crosse, Richland and Sauk counties.

Questionnaires contained a Contingent Valuation (CV) module with scenarios related to bioenergy cropping systems for corn stover and switchgrass.

- Three versions of the questionnaire were developed with different bid amounts (posed as land rental rates in $/acre).
- Approximately the same number of responses were received for each version.
- Table 1 reports the number of respondents who responded 'yes' to the initial bid at each level.
- Table 2 defines the explanatory variables used in the analysis.

The survey also included a follow-up bid (i.e., double-bounded dichotomous choice format)

- Results not shown

Stated Preference Data

Table 1. Summary of landowner responses

Bioenergy CV module	Initial bid price ($/acre)	Number of non-operator respondents	Number of 'yes' responses	Fraction who responded yes
Corn stover	5	138	3	2.2%
	25	133	15	11.3%
	55	139	14	10.0%
	Total	410	32	7.8%
Switchgrass	20	138	17	12.3%
	110	133	38	28.6%
	200	139	58	41.2%
	Total	410	113	27.6%

- Nearly 1 in 10 of the sampled landowners responded 'yes' at initial corn stover bid levels; more than 1 in 4 responded 'yes' for switchgrass.
- As expected, 'yes' responses as a share of total responses increased with bid price.
- Non-operator participation rates for switch-grass are higher than that for famers as reported in Mooney et al. Corn stover participation is lower.

Methods

We investigate the research questions by fitting parameters of the utility-difference model using independent probit regression (Hanemann):

$$D_j = \alpha T_j + \boldsymbol{Z_j}\boldsymbol{\beta_1} + \boldsymbol{Q_j}\boldsymbol{\gamma_1} + e_j$$

where,

- D_j is a binary response variable for the landowner j's supply decision, and
- T is the initial bid (in $/acre)

Hypothesis 1 (H[1]): Land-based income is not a source of utility for non-operators

- We test: H_0^1: $\alpha = 0$, vs H_A^1: $\alpha \neq 0$.
- The parameter α reflects the utility placed on income derived from the bid payment
- Rejection suggests income generation is an important determinant of supply decisions.

Hypothesis 2 (H[2]): Bioenergy & environmental preferences do not shape land supply decision

- We test: H_0^2: $\gamma_1 = \gamma_2 = \cdots = \gamma_m = 0$; vs H_A^2: $At\ least\ one\ \gamma_m \neq 0$.
- The parameters γ_m reflect landowner preferences for environmental quality
- Rejection implies preferences over non-pecuniary attributes of land shape decisions

Estimates of WTA are obtained as WTA = $(\boldsymbol{Q\gamma}+\boldsymbol{Z\beta})/\alpha$ (Haab & McConnell).

Table 2. Explanatory Variables

Household Income Variables	
Less than 50K	Household income less than 50K (1=yes, 0=no)
50 to 100K	Household income 50 to 99k (1=yes, 0=no
100 to 200K	Household income 100 to 199k (1=yes, 0=no)
Over 200K	Household income 200k or over (1=yes, 0=no)
Land Resource Variables	
Total land	Total land area owned (acres)
Cropland	Total cropland area owned (acres)
Pasture	Total pasture area owned (acres)
Woodland	Total woodland area owned (acres)
Open space	Total farmable open space area owned (acres)
Land Rental Variables	
Rents cropland	Household rents out cropland (1=yes, 0=no)
Rents pasture	Household rents out pasture (1=yes, 0=no)
Land Use Variables	
Land products	Uses land for hunting/non-forest prod. (1=yes,0=no)
Motor recreation	Uses land for motorized recreation (1=yes, 0=no)
Nonmotor rec.	Uses land for non-motor recreation (1=yes, 0=no)
Household Characteristics	
Land income	Share of household income derived from the land (%)
Residence	Maintains a residence on the land (1=yes, 0=no)
Age	Respondent age (years)
College degree	Respondent has college degree (1=yes; 0=no)
Bioenergy index	Index measuring bioenergy support (index, 0 to 4)
Prior knowledge	Had knowledge of crop's bioenergy use (1=yes, 0=no)
Environ. index	Index of preferences for environ. quality (index, 0 to 4)

Results

Marginal Effects on Adoption

Table 3. Marginal Effects of Explanatory Variables (in percentage points)

	Corn stover	Switchgrass
Initial bid price ($/acre)	0.076***	0.148***
Total land (acres)	0.014	0.294
Cropland (acres)	-0.019	-0.311
Pasture (acres)	-0.078	-0.137
Woodland (acres)	-0.003	-0.329*
Farmable open space (acres)	-0.051	-0.026
Rents cropland (1=yes,0=no)	2.622**	14.757***
Rents pasture (1=yes,0=no)	6.31**	2.591
Land products (1=yes,0=no)	5.834***	8.634
Motorized recreation (1=yes,0=no)	-5.285	-2.314
Nonmotorized recreation (1=yes,0=no)	-1.455***	-2.271
Land income share (%)	0.051	-0.867**
Residence (1=yes,0=no)	-3.322**	4.041
Age (years)	0.065	-0.213
College degree (1=yes,0=no)	2.038*	10.05**
Bioenergy index (integer)	1.194***	5.019***
Prior knowledge (1=yes,0=no)	-2.075*	3.665
Environmental index (integer)	0.095	4.414***

- Estimated probit coefficients on bid price (not shown) are all statistically different from zero at the 95% level, so H[1] is rejected.
- The expected probability of adoption increases as the bid price rises, when holding other factors constant.

Willingness to Accept

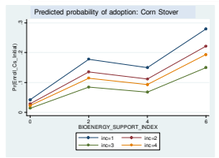
Table 4. Median WTA Estimates[#] ($/acre)

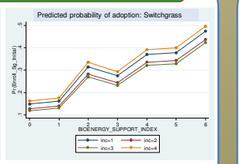
		All	Rents land	Does not rent land
Corn stover	Full sample	164	149	252
	Income < 50k	207		
	50 < Income < 100k	154		
	100 < Income < 200k	190		
	200k < Income	64		
Switchgrass	All	292	266	302
	Income < 50k	323		
	50 < Income < 100k	248		
	100 < Income < 200k	266		
	200k < Income	199		

[#]Evaluated at sample means

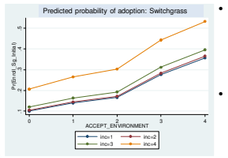
- Median WTAs for the sample of landowners are $164 and $292/ac for stover & switchgrass, respectively.
  - The lowest income group has the highest WTA; whereas the highest group has the lowest WTA.
  - WTA values are lower among non-operators who rent out cropland as compared to those who don't.
- 92% of sample currently rents cropland (377 of 410)
- Breakdown by income grouping: 25% (< 50K), 40% (50 to 99K), and 35% (100K & above).

Effect of Preferences





- Stronger preferences for bioenergy increase the probability of adoption for corn stover and switchgrass (above) (H[2] rejected).
- Bioenergy index captures beliefs about positive political, social & economic impacts, public involvement, etc.



- Preferences for environmental quality have a positive effect on switchgrass adoption (left); but not for corn stover (not shown).
- Environ. index captures willingness to engage in stewardship practices that enhance soil, water, wildlife habitat and climate.

Implications

- Non-operators' choice to supply land for bioenergy depends on economic and & non-economic incentives
  - Rental offer price is a significant determinant
  - Expected participation is higher among non-operators who currently rent land
  - Land owned by non-operators who *do not* currently rent out land could become economically-available, but at a much higher costs
- Non-economic factors affect corn stover and switch-grass differently
  - Preferences for bioenergy influence both corn stover and switchgrass
  - Preferences for environmental quality influence switchgrass but not corn stover
- In addition:
  - Corn stover negatively related to existing income sources from land and presence of a residence
  - Suggests dis-amenities from corn production may be a deterrent to corn stover; whereas positive amenities important for increasing switchgrass

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