Farmers' willingness to grow oilseeds as biofuel feedstocks for jet fuel production: A latent class approach

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Introduction

•Certified hydrotreated renewable jet (HRJ) fuels from plant oils have been commercially demonstrated and certified for aviation use. Its increasing popularity as an alternative fuel is primarily due to its operational, environmental, and economic benefits.

•Biofuels can be produced from a variety of feedstocks which account for 80-85% of the total biofuel production cost. This production cost increases as the cost of feedstocks increases due to the competition with other industries as well as their limited supply (Soriano and Narami, 2012). Consequently, prices of HRJ fuels are not competitive with petroleum-based fuels which compromise their production at a larger scale.

•As a consequence, there is a need to establish a dependable supply of high quality and low cost feedstocks (e.g. oilseeds) to help the biofuel industry meet the demand at competitive prices.

•Oilseeds are increasing on interest as feedstock crop for production of renewable fuels due to their diverse oil compositional structure that provides optimal oil properties for certified HRJ fuel conversion efficiency (Demirbas, 2007). Some varieties of oilseeds such as canola and camelina have been already successfully adapted to the western wheat belt region of the U.S.

•Although there are some studies that have looked at farmers' willingness to grow other feedstocks for biofuel production (e.g. energy sorghum, switchgrass, corn stover, etc.), few if any studies are focused on determining the farmers' willingness to grow oilseeds for producing bio-jet fuel.

Purpose

•To evaluate the farmers' willingness to adopt specialized oilseed crops usable for HRJ production into existing wheat based production systems under certain crop and contract attributes.

Objectives

1. To explore the general insights regarding producer preferences over the attributes of oilseed contracts by determining how oilseed variety characteristics and contract features that can affect on the decision of adopting oilseeds into the rotation system.

Importance

•Results of this study will: 1) help contractors measure how marginal changes in contract provisions will alter producer acceptance and adoption as well as analyze whether or not a crashing facility to process oilseeds is needed in the area to motivate adoption; and 2) provide policymakers with tools to measure the impact of government policies (i.e. financial incentives) regarding oilseed crops.

Data and Methods

Survey: A stated choice survey was administered to farmers in the western US who have non-irrigated wheat based cropping systems. The survey was conducted in the spring of 2013 to 10,000 wheat farmers in 11 western states: CA, CO, KS, MN, ND, NE, OK, OR, SD, TX, and WA, grouped in three regions: the Pacific Northwest Fruitful Rim, the Prairie Gateway, and the Northern Great Plains region.

A total of 971 responses were received (response rate of 9.7%). The survey questionnaire was organized in three sections: 1) Farmers' characteristics and management; 2) oilseed feedstocks for bioenergy and farmers' willingness to grow a specialized bioenergy oilseed crop under contract; and 3) crop adoption and perceptions towards biofuel feedstock production.

The main oilseed crops considered on this study are:


Canola


Flax


Camelina


Mustard sp.

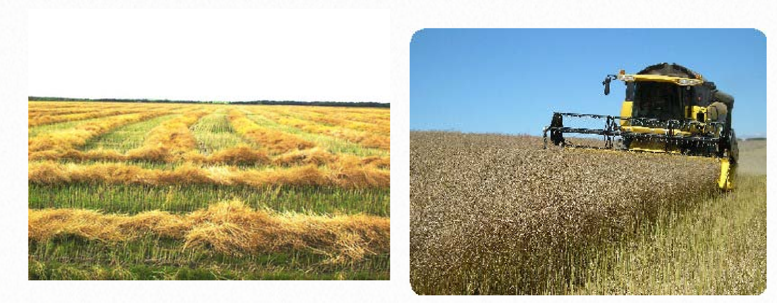

Safflower

Stated Choice Experiment:

Farmers were asked to consider contractual scenarios and choose if they would adopt a contract to grow oilseeds in rotation with wheat or "opt out." Each contract had nine attributes: 4 attributes related to oilseed characteristics and the other five described contract features.

Oilseed characteristics:


Pods shattering


Swath and Direct combine

An example of the 12 stated choice versions of the survey is shown in table 1.

Table 1. Stated choice question- Attributes and description of the contracts

	Characteristics	Description	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Oilseed Characteristics	Shatter resistance	The oilseed has improved shatter resistance	No	Yes	Yes	Yes
	Pest tolerance and resistance	Varieties have traits that provide herbicide and insect resistance	No	No	Yes	No
	Winter hardiness	Winter varieties are more resistant to winter weather	No	Yes	No	Yes
	Extended direct combine window	Oilseed has an extended window to direct combine and not swath	No	No	No	Yes
	Net returns	Expect percent gain above the net returns for producing an acre of wheat	25%	5%	25%	5%
Contract Features	Length of contract	The time commitment in consecutive years of the contract	1 Year	3 Years	1 Year	1 Year
	Crop insurance	Crop insurance is available in the market for this crop	Yes	Yes	No	No
	Cost share	Biorefinery or processor agrees to cover a percentage of the input costs	30%	15%	15%	30%
	"Act of God"	The contract includes an "Act of God" clause	Yes	No	No	Yes
	I would probably be willing to grow an oilseed crop under contract for this scenario		1=Yes 2=No	1=Yes 2=No	1=Yes 2=No	1=Yes 2=No

Model

A choice experiment method is used to investigate producers' willingness to adopt oilseeds. Particularly, a latent class model (LCM) approach is used to account for the heterogeneity of the preferences in the sample. According to Greene and Hensher (2003), the choice probability of the individual *i*, among choice *Ji* alternatives, at choice situation T*i*, given that she/he is in the class *q* is given by the following equation:,

Pr[choice *j* by individual *i* in choice situation *t*|class *q*]=

$$\frac{\exp(x'_{it,j}\,\beta_q)}{\sum_{j=1}^{J_i}\exp(x'_{it,j}\,\beta_q}=F(i,t,j\,|\,q)$$

The probability for the specific choice made by an individual is:

$P_{it|q}(j) = \text{Prob}(y_{it}=j\,|\,\text{class } q)$

Results and conclusions

The LCM was estimated for up to five segments per each region. The Akaike Information Criterion (AIC) was used to choose the best fitting LCM. For all regions, the LCM model includes variables such as: 22 to 57 years old wheat producers, the average yearly total gross value of sales coming from the producers' agricultural operation, and farm size measured on total acres. In the case of the Pacific Northwest region, gender and off farm work were also included in the model. Results for the LCM are shown in table 2.

Table 2. Latent class model estimates for oilseed attributes by region

	Pacific Northwest		Prairie Gateway			Northern Great Plains	
Atributes	LC1	LC2	LC1	LC2	LC3	LC1	LC2
Net returns	0.0128	0.1182 ***	0.031	0.2157 ***	0.0667 ***	0.031 **	0.111 ***
	(0.0354)	(0.0260)	(0.0493)	(0.0295)	(0.0087)	(0.0135)	(0.0251)
Shatter resistance	0.2336	0.3679 ***	0.2223	0.5528 ***	0.1551 **	0.1697 *	0.0477
	(0.1844)	(0.1089)	(0.3867)	(0.179)	(0.0696)	(0.0898)	(0.1541)
Pest tolerance and resistance	0.5002 **	0.0481	0.2862	0.4995 ***	0.3251 ***	0.3514 ***	-0.288 *
	(0.2046)	(0.1197)	(0.3845)	(0.1748)	(0.0676)	(0.0956)	(0.1539)
Winter hardiness	0.1194	0.3495 ***	0.0007	0.1687	0.2756 ***	0.0545	0.0923
	(0.1919)	(0.1144)	(0.4014)	(0.1367)	(0.0692)	(0.0891)	(0.1454)
Extended direct combine window	0.5298 ***	0.199 *	0.3489	0.3194 **	0.521 ***	0.4532 ***	0.3384 **
	(0.2018)	(0.1074)	(0.4014)	(0.1403)	(0.0654)	(0.0919)	(0.1567)
Length of contract	-0.8484 ***	-0.3187 ***	-3.7229 ***	-0.4309 ***	-0.4764 ***	-0.6066 ***	-0.2021 **
	(0.1708)	(0.0748)	(0.7823)	(0.0978)	(0.0498)	(0.0732)	(0.0925)
Crop insurance	0.4595 **	0.3384 ***	0.6307	-0.1999	0.5689 ***	0.2353 ***	0.358 **
	(0.1914)	(0.111)	(0.4346)	(0.1507)	(0.0719)	(0.0896)	(0.154)
Cost share	-0.0115	0.005	0.0223	0.0538 ***	-0.0101 **	-0.0096	0.035 ***
	(0.0124)	(0.0086)	(0.0305)	(0.0114)	(0.0047)	(0.0062)	(0.0115)
Act of God	0.3696 **	-0.0154	0.8058	0.8141 ***	0.4129 ***	0.6163 ***	0.3457 **
	(0.1869)	(0.1172)	(0.5883)	(0.1703)	(0.067)	(0.096)	(0.1478)
Class Probability							
Constant	0.6326		1.5738 ***	-0.4388		4.2285 ***	
	(1.5864)		(0.5419)	(0.6503)		(1.2628)	
Age (22-57)	-0.2249		-0.0261	-0.0272		-0.0003	
	(0.7826)		(0.2981)	(0.2982)		(0.0018)	
Yearly total gross value of sales	-0.6485 **		0.0142	0.307 **		-0.597 ***	
	(0.3114)		(0.1156)	(0.1208)		(0.2036)	
Land acreage	-0.2943		-0.5942 ***	-0.6083 ***		0.159	
	(0.3744)		(0.1997)	(0.1998)		(0.306)	
Gender	0.2192						
	(0.7834)						
Off farm work	2.6651 **						
	(1.1589)						
Model fit statistics							
Number of respondents		142			404		268
Number of observations		568			1616		1072
Restricted log likelihood		-393.7076			-1120.126		-743.0538
AIC		1.13236			1.03013		1.13306
McFadden Pseudo R^2		0.24693			0.28816		0.21228

***, **, * indicate statistical significance at 1%, 5%, 10% level, respectively.

Standard errors in parenthesis

Contract features: As expected, producers from all regions and classes prefer shorter contract length. The majority of the producers prefer having crop insurance and an "Act of God" clause in their contract. Only those from class 2 and class 3 from the Prairie and the Northern regions, respectively prefer having cost-share with a bio-refinery. Regarding to oilseed characteristics, the majority of producers prefer pest tolerant varieties and extended direct combine window. Shatter resistance is a less preferred attribute. Winter hardiness is only preferred for class 2 producers from the Pacific region and class 3 from the Prairie region.

Class probability: For the ***Pacific region;*** producers who work off farm and have lower yearly total gross value of sales are more likely to belong to class 1. **Prairie region*:*** Producers who have lower acreage are more likely to belong to class 1, while those who have greater yearly total gross value of sales from their agricultural operation and less acreage are more likely to belong to class 2. **Northern region*:*** Producers who have lower yearly total gross value of sales are more likely to belong to class 1.

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