Biomass Contracts for Ethanol Production: The Role of Farmer's Risk Preferences

By

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Abstract

This study analyze what contracting terms provides sufficient incentives for farmer’s to enter into a contract to produce energy beets for biofeul production. A stated choice experiment was designed to elicit farmer’s preferences to grow energy beet under alternative contractual arrangements. A latent class rank-ordered logit [LCROL] model is used to empirically analyze the effects of contract attributes, farmer’s risk preferences, and farm characteristics on willingness to adopt energy beet. The results shows that the way the contract mechanism is designed significantly affects farmer’s preference to rank contract alternatives. Few risk perception factors extracted from farmer’s response play a role on the preference of contracts.

Keywords: Contracts; Risk Preferences; Energy Beets; Ethanol; Rank Order Logit Model.

1. Background

The 2007 Energy Independence and Security Act (EISA) amended and established renewable fuel standards (RFS2) with a goal to use at least 36 billion gallons of bio-based transportation fuels, annually, by 2022. Of this amount, 15 billion gallons can come from conventional ethanol produced from corn starch. The remaining 21 bgy must be advanced biofuels, including 61 mmy from cellulosic feedstocks. The RFS2 mandate also capped corn ethanol use at 15 bgy in 2015 and beyond. Currently, the corn ethanol industry has reached the annual minimum production capacity required to meet the 'conventional' RFS2 mandate (Renewable Fuel Association, 2015). Therefore, future growth in biofuel production is likely to come from alternative feedstock pathways, including dedicated energy crops and high-sugar feedstocks. High-sugar feedstocks, such as sugar beets, sugar cane and sweet sorghum, are expected to fulfill some of the feedstock requirement in the EISA advanced biofuels goal.

The conversion of these feedstocks into biofuels and their commercial viability are mainly determined by investment and feedstock costs, conversion efficiency, the price of biofuels, markets, and infrastructure for the production, harvest, storage, and delivery of these dedicated energy crops (Alexander et.al 2012; Babcok 2012; Coyle, 2010; Epplin et al.,2007). Regardless of these uncertainties, in 2013, the California Energy Commission (CEC) funded a $5 million project to construct and test a demonstration beet-ethanol biorefinery (CEC, 2013). Since 2009, progress has been made by private developers in North Dakota in developing a flexible biorefinery plant capable of producing energy beet based industrial sugar juice, biofuels, and possibly bioproducts, and other byproducts, in a single facility.

The energy beet, a member of the beet family (Beta vulgaris), is a hybrid sugar beets that has been genetically engineered in various parts of U.S to yield sugar for ethanol production

(McGrath and Townsend 2015). Although energy beets are specific to the U.S, sugar beets are used in Europe for ethanol and sugar production.

Given huge initial investment costs, and risk and uncertainty about beet feedstock cost and availability, potential new beet ethanol refineries need to rely on long-term contracts to convince farmers to produce and deliver energy beet feedstock over time. Farmers will not adopt and sign a long term contract unless the payoff from producing the energy beet is at least as high as the payoff from the next best use of the land. Well-designed contracts, with price and other production incentives, may encourage farmers to engage in the production of biofuel feedstock and aid in achieving return on investment targets, while still providing incentives to meet the quantity and quality targets of the refineries (Alexander et.al 2012; Epplin 2007; Epplin and Haque 2011; Babcok 2012; Larson, English and He, 2008).

The purpose of this study is to evaluate the impact of contract attributes on farmers' willingness to sign energy beet supply contracts, when choosing from a menu of possible offers. We assess the effects of contract terms, and landowners' heterogeneous risk preferences and levels, on the choice between producing conventional crops or energy beets in rotation. A stated choice experiment was designed to elicit farmers' willingness to grow energy beets as a bioenergy crop under alternative contractual arrangements. A latent class rank-ordered logit [LCROL] model was estimated to evaluate the role played by contract attributes and farmers' risk perception on their ranking preference of the contract terms offered. The econometric estimation is based on a sample that consists of 43 farmers, surveyed in person and online. The study proceeds with an overview of the survey, followed by the empirical model. The findings of the empirical model are then reported and discussed. The last section contains the conclusions and implications of the study.

2. Energy Beet Willingness-to-Grow Survey of North Dakota

Survey techniques were employed to elicit North Dakota agricultural producers' willingness-to-grow energy beets. A two-phase survey technique was employed to encourage survey participation. The survey was initially administered in person, as a paper version, following energy beet educational sessions in five North Dakota Cities: Valley City, Jamestown, Langdon, Carrington and Cando, from March 17th to March 19th, 2015. The initial paper survey elicited 28 responses. The survey was then converted to an online format and transmitted to agricultural producers via extension networks established through North Dakota State University. Online efforts began in April with subsequent participation efforts occurring in May of 2015. The data set has 15 additional online survey responses for a total of 43.

The survey has four distinct sections requiring farmer input. The first section collects farmer demographics and information about their farm enterprise. The second section of the survey elicits various attitudes of the producer, including perceptions of risk, willingness to adopt new technologies and crops, and general attitudes about contracts, capital investment, insurance, labor and the environment. It also contains questions about energy beet knowledge and general attitudes toward growing them.

The third section of the survey is specifically geared toward investigating farmer preferences between different types of contract design mechanisms. The section is broken down into questions surrounding energy beet product pricing and quantity supplied in the contract. Farmers were asked about their preference for fixed per unit prices for beet delivery, compared to three alternate formulas based on the price of corn. They were asked to rank their preferences between: 1) Fixed; 2) Formula (10x Chicago Corn); 3) Formula with a Floor; and 4) Formula with a Ceiling. "Fixed" prices would be set throughout the life of the contract. "Formula" prices would be set at ten times the Chicago nearby futures price with a maximum price paid to the farmer (ceiling) to protect the ethanol producer, or a minimum price paid to the farmer (floor) to limit downside risk. They were also asked to rank their preferences for these types of pricing mechanisms for 1-year, 5-year and 10-year contracts to examine the effect of contract length on these preferences.

Similarly, respondents were asked to rank their preferences between four quantity requested by the plant options: 1) All Production; 2) All Production Minimum Required; 3) Capped No Additional; 4) Capped Negotiated Price. In “All Production”, the entire crop of energy beets, regardless of size, would be delivered. In “All Production Minimum Required”, the farmer would be responsible for finding (or paying for) product that they were unable to deliver. In “Capped No Additional”, a specific amount would be negotiated for acceptance and no more could be delivered. In “Capped Negotiated Price”, the farmer would be able to negotiate a price for any production over the specified amount. Preferences for these quantity mechanisms were also ranked for 1-year, 5-year and 10-year contracts.

The final section of the survey uses a stated choice approach to attempt to elicit energy beet willingness-to-supply by asking farmers to make a production commitment based on contract attributes. More specifically, farmers were asked to commit a percentage of their land based on a percentage increase in their net returns, a contract length, a contract pricing mechanism, a quantity accepted mechanism and a harvest method. This final section of the survey is not the focus of this paper, which deals primarily with attitudes defined in the second section and the pricing and quantity mechanisms defined in the third section of the survey.

3. Empirical Model

3.1 Latent-class Rank-ordered Logit (LCROL) Model

The main goal of this study is to evaluate the effects of contract attributes and risk preferences on willingness to sign energy beet contracts. A latent class rank-ordered logit [LCROL] model is used to empirically estimate farmers' preferences. The framework of the LCROL is based on the work of a number of authors (Fok et al. 2012; Chapman and Staelin 1982; Hausman and Ruud 1987; Train 2008). We assume that a farmer makes energy beet production choices to maximize subjective expected utility given production technology and short-run fixed input constraints. If we observe a farmer choosing to grow and supply energy beets under a specified contract, then we assume that the subjective expected utility from producing energy beets under that specified contract exceeds that of producing energy beets under alternatively-specified contracts, as well as his next-best traditional crop alternative (McFadden 1973, 1974; Roe, Sporleder, & Belleville,2004; Bergtold et al. 2012).

The rank ordered logit model can be derived from a random utility model as in the conditional logit (CL) model, assuming that the objective of the producer is to maximize expected discounted utility, over time, when choosing between contracts to produce and supply energy beets. Thus, the random utilities for individual producer i are a set of latent variables (U_{i1}). U_{ij} denotes:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad \text{for} \forall \ , \ j \in J \tag{1}$$

Where $i = 1,....., N$ indexes respondents and $j = 1,....., J$ indexes the contract alternatives. The utilities consist of two parts: V_{ij} is the deterministic component of the utility, which is determined by observed individual characteristics and the attributes of the alternative. The second component ε_{ij} is the random component of the utility of alternative j for individual i and it captures the factors that affect utility, but are not included in V_{ij} .

In general, the reduced-form of the deterministic part of the utility is modeled as:

$$V_{ij} = \beta' x_i + \phi Z_j + \theta W_{ij} \qquad (2)$$

Where x_i is an *m*-dimensional vector with characteristics of individual i and j is an *m*-dimensional parameter, vector specific to alternative j, Z_j depicts the contract attributes - the contract length in years and the potential contract pricing/quantity schemes, and W_{ij} denotes attributes that may vary with both respondents and contracts, where β , ϕ and θ are the row parameter vectors of interest. The model is estimated assuming that the random component is independent and identically distributed with a Type-I extreme value distribution.

Fok et.al (2012) discussed that in the traditional setup, respondents are asked to choose their most preferred out of the complete set of J alternatives. Let $y_{ij} = 1$ denote that respondent i most prefers option alternative j.The information $y_{ij} = 1$ implies that, for this respondent, the utility of alternative j is larger than all other alternatives (i.e., $U_{ij} \geq Max(U_{i1} ....U_{ij})$). The probability of this event depends on the distribution of ε_{ij} . If we assume that ε_{ij} has an independent type-I extreme value distribution, we have the setup of a multinomial logit [MNL] model (McFadden 1973; 1974). This leads to the expression for the probability that item j is most preferred by individual i :

$$P_{ij} = \Pr[y_{ij} = 1; \beta] = \Pr[U_{ij.} \geq Max\{U_{i1.}........U_{ij.}\}] \;\; = \frac{\exp(V_{ij})}{\sum_{l=1}^{j} \exp(V_{il})} \qquad (3)$$

Where $\beta = \{\beta_1, ...\beta_j\}$ and β_j is set equal to zero for identification. The information on the most preferred item is enough to estimate the model parameters. However, an efficiency gain can be obtained if we ask for a ranking of alternatives. We will denote the response of respondent i by the vector $y_{ij} = (y_{i1}, ..., y_{ij})'$ where y_{ij} now denotes the rank that individual i gives to item j. We also use an equivalent notation $r_{ij} = (r_{i1}, ..., r_{ij})'$ where r_{ij} denotes the contract alternative that receives rank j by individual i. Note that $y_{ij} = j$ is equivalent to $y_{ij} = k$. Under this assumption, individual farmers know all utility values and can easily provide a full ranking. Given the assumptions made on individual utilities, the probability of observing ranking r_i equals:

$$\Pr[r_i; \beta] = \Pr[U_{ir_{i1}.} \succ U_{ir_{i2}.} \succ .... \succ U_{ir_{ij}.}] = \prod_{j=1}^{J-1} \frac{\exp(V_{ir_{ij}})}{\sum_{l=j}^{J} \exp(V_{ir_{lj}})} \tag{4}$$

The above expression is known as the ROL model (Beggs et al., 1981; Chapman and Staelin, 1982). The ROL model can be seen as a series of multinomial logit (MNL) models. Equation (4) only implies that we can look at the ranking as if consecutive choices are made (Fok et.al 2012).

The ROL model assumption that respondents are able to rank each contract according to the underlying utilities does not always hold, especially for the less preferred contracts (Chapman and Staelin 1982). This argument implies that respondents do not make a complete ranking order for observed alternatives properly- farmers are only able to rank $J-k$ contracts. If the least preferred contracts are not ranked according to the underlying utility model, the use of those ranks in the estimation will bias the parameter estimates towards zero (Chapman and Staelin 1982; Hausman and Ruud 1987).

The contract choice set J comes from the farmers' selection of the most important contract and they were asked to rank only their top k_i beet contract (Fok et al., 2012; Hausman and Ruud, 1987). This implies that the assumption that all contract that were not chosen by the farmers, $J-k_i$, are ranked lower than his last choice contract. If the ranks beyond k are biased, the probability of observing a particular contract ranking by individual i, given that only the k most preferred items are ranked becomes:

$$\Pr[y_i \mid k;\beta] = \Pr[U_{ir_{i1}.} \succ U_{ir_{i2}.} \succ .... \succ U_{ir_{ij}.}] = \prod_{j=1}^{k_i}\left[\frac{\exp(V_{ir_{ij}})}{\sum_{l=j}^{J}\exp(V_{ir_{lj}})}\right]\frac{1}{(J-k_i)!} \tag{5}$$

We assume that the least preferred $J-k$ contracts are ordered randomly. Hence, the last term in Equation (5) contains the probability of observing one particular ordering of the last $J-k$ contracts (Fok et al., 2012).

The estimation of this model implies the following log-likelihood function for a sample of N independent respondents:

$$\log\widetilde{L}(\beta, p) = \sum_{i=1}^{N}\log\left\{\sum_{k=0}^{J-1} p_k \exp\left[-\log((J-k)!) + \sum_{l=1}^{k}\left(x_i{}'\beta_{r_{il}} - \log\sum_{m=l}^{J} e^{x_i{}'\beta_{r_{im}}}\right)\right]\right\} \tag{6}$$

Two specific contract attributes, price and quantity mechanisms, were presented to farmers and they were asked to rank four options for each attribute, as defined in Section 2. We ran two independent models, one for each attribute. The other common ordinal explanatory variables for each model are: contract length (1, 5 and 10 years), age, education and annual farm sales. Two dummy variables indicating farmers' membership in input and process cooperatives are also part of the explanatory variable. Finally, continuous variables include total crop acreage harvested and three factor variables extracted from factor analysis representing farmers' risk perceptions.

3.2 Factor Analysis

In the stated choice survey we designed twenty two attitudinal questions to capture farmers' perceptions of risk related to farm and financial management, willingness to adopt new technologies and crops, and general attitudes about contracts, capital investment, insurance, labor and the environment (Section 2). We then applied factor analysis to condense these attitudinal questions into three latent perception factors to reduce data dimensionality (Bard and Barry 2000, 2001). Farmers' preferences for contract choices are characterized by heterogeneities (Lajili, Barry, Sonka 1997; Boxall and Adamowicz 2002; Bard and Barry 2000). These heterogeneities could be explained either in the form of observed and unobserved farm or individual characteristics. Incorporating and understanding heterogeneity will provide information on the distributional effects of resource use decisions or policy impacts (Alexander et.al 2012; Bard and Barry 2000; Bergtold et.al 2012; Boxall and Adamowicz 2002).

We first inspect the risk perceptions data responses by fitting a polychoric correlation matrix to measure the association of two theorized normally distributed continuous ordinal variables. Then we assessed the suitability of the ordinal variable data for factor analysis (FA) using the Kaiser–Meyer–Olkin (KMO) index. KMO is a measure of sampling adequacy and high values of the index indicate that FA is appropriate.

We fitted an iterated principal factors model to derive the three latent class factors and the estimated factors derived from the FA were later employed in the regression analysis. The decision to retain the number of factors in the three latent classes were determined based on

Eigenvalues and factor loading. Factor loadings are the weights and correlations between each variable and the factor. Factor loadings indicate the relative importance of each variable to each factor. We retain variables with factor loadings greater than 0.3. The higher the load the more relevant it is in defining the factor's dimensionality. The latent perception factors supported by the FA are: 1) management risk including production, technology, and marketing activities; 2) institutional risks related to perceptions towards cooperative memberships and engagement in vertically integrated markets; and 3) investment risk.

4. Results

The results presented in this study are still in the preliminary analysis phases. Efforts are underway to increase the response rate of the survey. As more data becomes available, the preliminary results and conclusions presented in the following sections will continue to evolve.

In the stated preference survey, each respondent was asked to rank both price and quantity mechanisms in energy beet supply contracts. Each contract mechanism had four options (Section 2) and respondents then were asked to rank all four alternatives, from most (=1) to least (=4) preferred. Of the 56 farmers that attempted any participation in the survey, 43 responded regarding their general interest in growing energy beets. Thirteen respondents were dropped since they did not participate in the price and quantity mechanism ranking. Out of the 43 respondents who participated in the ranking, about 95% of the farmers gave a complete ranking regarding price, while quantity was ranked completely. Table 1 through 3 present the descriptive statistics for all of the explanatory variables used in rank order models.

Table 4 shows the preliminary results for the three perception latent factors extracted. The KMO measure of sampling adequacy (KMO) was 0.6716, showing an adequate fit. Kaiser (1974) labelled KMO values greater than 0.5 as acceptable and 0.8 or higher as desirable. Factor loadings greater than or equal to 0.30 (in absolute value) are used to make inference about farmers' risk perception effects on latent perception factors. We excluded variables with factor loadings lower than 0.3 (in absolute value). Eigenvalues for the first twelve factors are greater than or equal 0.6 and explain 89% of the variance in the data. Factor 1, management risk, consisted of seven risk perception questions with factor loadings ranging from 0.39 to 0.61. The seven items contributing to management risk are questions 2, 7, 8, 9, 14, 18, 19, 20 and 22 from Table 4. Factor 2, institutional risk, is composed of question 1, 3, 4, 5, 6, and 12. Factor 3, investment risk, is composed of questions 11, 13 and 15. Question 10 was left out of the factor groups as its factor loading was less than the cutoff value.

Table 5 presents the preliminary parameter estimates and bootstrap standard errors for the rank ordered logit models for pricing and quantity contract schemes. The second column of Table 4 displays the parameter estimates for pricing schemes and the fourth column displays the quantity based ranking scheme. Under ROL, we implicitly assume that each farmer is capable of performing the complete ordering task.

For both models, many parameters that explains farmer's characteristics were not statistically significant. We noticed that farmers' individual characteristics, such as age, education, size of farm (acres) and being a member of an input or processing cooperative, did not play a significant role on ranking preferences. This result implies that being older or younger does not play a significant role in contracting, which is contrary to the common hypothesis that older farmers may be less interested in contracts. Likewise, our results revealed that being more or less educated has no role in contract preferences, which runs against the hypothesis that more educated farmers tend to be more interested in contracting. However, the coefficient estimates on contract attributes played a significant role in ranking order, implying that contract design affects ranking order and farmers' decisions to adopt energy beets. It appeared that higher net farm sales negatively affected the probability of an attribute being ranked first for price mechanisms. Given our data sample is very small, it is not surprising to see that contract length did not affect farmers' ranking preferences. However all attributes on contract mechanism design are statistically significant at all levels.

Among three risk perception factors included in the model, institutional risk was the only predictor factor that is significant at the 10% level. That is, higher favorable perception of farmers' towards institutions significantly affects the probability of the attribute being ranked first, all else being equal.

We also presented the predicted probability of each rank order at the bottom of Table 5. The probability results on quantity based contracts show a clear bias towards each ranking as respondents were tempted to sort them according to the order in which the contracts appear in the survey. The way the rankings were presented in survey was not randomized.

For ease of exposition, we reported the marginal effects for significant parameter estimates in Table 6. The marginal effects show the probability of a contract with mean attribute values being the top-ranked choice given that a contract attribute changes for the farmer. Results from the marginal effects show that formula with a floor has a marginal effect of 7.9 while formula with a ceiling was the least preferred with a marginal effect of 5.9. The Formula and fixed contracts come second and third with 7.1 and 7.0, respectively. Similarly, farmers preferred "All Production" most with a marginal effect of 3.57. "Capped Negotiated Price" came second with a marginal effect of 1.61, whereas "All Production Minimum Required" was the third most preferred option with a marginal effect of 1.25.

The regression results from the price mechanism indicated that farmers most preferred formula with a floor as it passes some of the yield and price risk to the refinery. Formula with a ceiling for a given quantity of energy beet biomass delivery is the least preferred as it might expose farmers to energy crop yield and price risk. The optimal contract may involve a contract that ensures risk sharing between the landowners and the biorefinery that minimizes their joint risk premia (Alexander et.al 2012), probably incorporating both a floor and a ceiling.

Finally, the results show that the standard error of the parameter estimates for quantity mechanisms was smaller compared to pricing, corroborating the theory that standard errors become much smaller if the full ranking is used (Fok et.al 2012).

5. Conclusion and implication of the findings

In this study we investigated the effect of specific contract attributes and farmers' risk preferences on willingness to accept hypothetical contracts to produce energy beets for ethanol production. A stated choice experiment was designed to elicit farmer preferences to grow energy beets under alternative contracts in selected counties of North Dakota. We developed a latent-class rank-order logit model, which accounts for individual preference heterogeneity, to analyze two contract attributes specifically ranked by respondents: price and quantity. Factor analysis was used to group farmers' risk perception responses into three categories: management risk; institutional risk; and investment risk. The resulting risk factors were included in a rank-order logit regression model.

Results showed that only the institutional risk factor plays a significant role with respect to farmers' preferences to grow energy beets under contract. Management and investment risk factors were not statistically significant, implying that they play little or no role with respect to farmers' contract attribute preferences. Our analysis reveals that farmer demographic characteristics, such as age, education, size of farm, and cooperative membership, do not play a significant role in ranking contract attributes. However annual net farm sales was statistically significant at the 10% level, and had a negative impact on the likelihood of farmers ranking preference of contracts.

Among the price mechanism alternatives, formula with a floor has a significant probability of being top-ranked. Similarly, all production has the highest probability of being the top-ranked alternative quantity mechanism.

As stated, the results presented in this study are still in the preliminary analysis phases. Efforts are underway to increase the response rate of the survey. As more data becomes available, the preliminary results and conclusions presented will continue to evolve.

Our study provides insights in understanding farmers' preferences for key contract attributes. The results could contribute to the development of a new feedstock for advanced biofuel production by illustrating the factors that affect farmers' decision making for the type of contract elements that shape future streams of profit from adopting energy beets. Analysis of the impacts of potential biomass attributes and farmers' risk preferences is also crucial to identify potential barriers to adoption of energy beet biomass and create an efficient biomass supply chain that can help to procure biomass in a cost effective manner to support the development of advanced biofuel industries. Our modeling approach provides insights in understanding farmers' preferences for key contract attributes and helps to explore factors that affect farmers' decision making when they are offered a contract by biofuel refinery owners. It also helps to identify the ways that biomass production in a region may be vertically integrated with biofuel industries.

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Table 1 Descriptive statistics: percent of each rank by contract attribute

Table 2 Descriptive statistics: percent of each rank by contract attribute

	Price					Quantity				
Rank	Ceiling	Fixed	Floor	Formula	Total	All Prod	Minimum	Negotiated	No Add	Total
0	9	2	5	7	6					
1	3	37	49	11	25	79	9	15	1	27
2	9	17	28	40	24	15	31	37	9	23
3	28	23	16	24	23	4	39	36	18	24
4	51	20	2	17	23	2	21	12	71	26

Legend: Fixed; Formula (10x Chicago Corn); Floor (Formula with a Floor); Ceiling (Formula with a Ceiling); All Prod (All Production); Minimum (All Production Minimum Required); Negotiated (Capped Negotiated Price), No Add (Capped No Additional).

Table 2 Descriptive statistics: mean ranking by contract attribute

Table 3 Descriptive statistics: mean ranking by contract attribute

	Contract Length (years)				Contract Length (years)		
Price	1	5	10	Quantity	1	5	10
Ceiling	2.5 (0.89)	2.4 (0.86)	2.4 (0.94)	All	1.3 (0.62)	1.3 (0.67)	1.3 (0.67)
Fixed	1.3 (0.62)	1.3 (0.67)	1.3 (0.68)	Minimum	2.8 (0.87)	2.7 (0.92)	2.7 (0.92)
Floor	3.6 (0.75)	3.6 (0.67)	3.6 (0.67	Negotiated	2.5 (0.89)	2.4 (0.86)	2.4 (0.86)
Formula	2.8 (0.87)	2.7 (0.92)	2.7 (0.94)	No Add	3.6 (0.75)	3.6 (0.67)	3.6 (0.67)

Standard errors in parentheses.

Table 3 Descriptive statics for variables used in rank order logit model

variable	mean	Std.Err
age	3.64	1.25
Education	3.41	0.99
acreage	3820	3165
sale	3.16	0.93
input coop	2.18	0.96
process-coop	2.68	0.63
Management	3.77	0.44
Institution	3.03	0.52
Investment	2.27	0.75

Legend: Price and quantity rank (=1, 2, 3, and 4: from most to least preferred). Price attribute (1= Ceiling, 2=Fixed, 3= floor, and 4=formula), Quantity attribute (1= all prod, 2= minimum, 3= negotiated, and 4= no-add), length (1, 5, 10 years), age (1=<25, 2= 25-34, 3=35-44, 4=45-54, 5=>55), education (1= some high school, 2=high school diploma, 3=some college, 4=undergraduate degree, 5=graduate degree) , acreage *(total acres planted to crop in 2014), sale (annual farm sale 1=<100k, 2=100k-499k, 3=500k-1mn, 4=>1mn), Input coop (1=yes to member to input coops, 2=No), Process-coop (1=yes to member to process coops, 2=No), Management, Institution and Investment are factors extracted from factor analysis.*

Table 4 Factor loading for attitudinal questions

Table 1. Factor loading for attitudinal questions			
Attitudinal questions	Management	institutional	Investment
1. I am hesitant to change my crop rotation		-0.481	
2. I am more likely to grow new crops when my current crop prices are low	0.500		0.394
3. I prefer to use technologies I am familiar with rather than adopting new on		-0.312	
4. I prefer to conduct business as a member of a cooperative		-0.501	0.307
5. I prefer short-term supply contracts to long terms ones		-0.339	
6. Contracts should tie the price I receive for beets to the price of other crop		-0.374	
7. I need higher returns when growing new crops	0.399	-0.446	
8. I am willing to make capital investments for new on-farm enterprises	0.631		-0.308
9. I am willing to lease equipment	0.390	0.347	
10. I have a high tolerance for financial risk			
11. I am willing to grow crops without insurance	-0.373		0.439
12. I prefer to harvest myself, rather than hire it done		-0.350	
13. Labor availability during harvest is not an issue in my area			0.587
14. I am willing to hire extra labor to harvest my crops, if necessary	0.542	0.560	
15. I am willing to receive lower returns to support local economic devt		0.317	0.699
16. I consider myself well educated on environmental issues		0.450	
17. I consider my operation to be environmentally friendly		0.406	
18. I am willing to receive limited returns to provide envl benefits to	0.388		0.573
19. I require price premiums to grow environmentally friendly products	0.534		
20. Chemical carryover is a concern for beets	0.467	-0.300	
21. Beets provide soil health benefits	0.478		
22. Beets have a spot in my rotation	0.578	0.336	

Note: Empty cells shows factor loads that are less than 0.3. The Likert scale for attitudinal questions on a scale from 1 = “strongly disagree” to 5 = “strongly agree”.

Table 5 Coefficients for rank order logit model estimates for price and quantity based attributes

Table 4 Coefficients for ROLM estimates for price and quantity based attributes

Price based contract			Quantity based contract		
Variable	Coefficient	Std.Err	Variable	Coefficient	Std.Err
fixed	1.227***	(0.279)	minimum	-2.321***	(0.533)
floor	2.024***	(0.186)	negotiated	-1.961***	(0.592)
formula	1.112***	(0.335)	no-add	-3.798***	(0.601)
length (5yrs)	0.049	(0.048)	length (5yrs)	-0.0193	(0.0274)
length (10 yrs)	0.026	(0.074)	length (10 yrs)	-0.0441	(0.0411)
age	4.065	(33.76)	age	0.168	(15.69)
edu	6.49	(5.365)	edu	0.195	(53.28)
acreage	-0.001	(0.010)	acreage	0.0001	(0.016)
sale	-61.13***	(9.066)	sale	0.221	(12.56)
input-coop	1.16	(9.776)	input-coop	0.978	(11.11)
process-coop	11.66	(16.01)	process-coop	-0.732	(6.435)
management	8.83	(54.04)	management	0.450	(12.33)
institution	-12.92+	(7.833)	institution	-0.574	(7.840)
investment	2.48	(19.27)	investment	0.223	(59.41)
P_0	0.070	(0.054)		-	-
P_1	0.330	(0.051)		0.631	(0.100)
P_2	0.266	(0.050)		0.200	(0.090)
P_3	0.204	(0.049		0.111	(0.051)
P_4	0.129	(0.031)		0.058	(0.040)
Log-LH	-464.8			-336.7	
BIC	1,011			760	

NOTE: $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001. Standard errors in parentheses and is based on bootstrap methods. The base alternatives are ceiling and all production in price and quantity based contract models respectively.

Table 6 Marginal effects (%) for Rank order logit model

Table 6 Marginal effects (%) for Rank order logit model					
Price based contract			Quantity based contract		
	Margin	Std.Err		Margin	Std.Err
ceiling	5.91^{***}	6.13	all prod	3.57^{*}	7.25
fixed	7.14^{***}	6.12	minimum	1.25^{**}	7.37
floor	7.94^{***}	6.13	negotiated	1.61^{**}	7.35
formula	7.03^{***}	6.16	no-add	-0.23^{***}	7.34

NOTE: $^{+}$ *p < 0.10,* * *p < 0.05,* ** *p < 0.01,* *** *p < 0.001. Standard errors in parentheses and is based on delta methods.*