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An Evaluation of Tennessee Soybean Growers' Views on a New Generation Cooperative to Produce Biodiesel

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Substituting petroleum diesel with biodiesel could decrease air emissions, reduce reliance on foreign oil, and help expand markets for U.S. farmers. Soybean producers can potentially capture this value-added by forward integrating the processing of soybeans into biodiesel via a New Generation Cooperative (NGC). Using probit analysis, this study examines factors influencing soybean producers' willingness to participate in an NGC to produce biodiesel. Tobit analysis is used to examine the factors influencing the number of shares the soybean producer would be willing to purchase. Survey results indicate that over 70% of the soybean producers in the study group are interested in investing in an NGC to produce biodiesel. Among those producers willing to participate, the average number of shares they would purchase was just under 3,460.

Key Words: biodiesel, New Generation Cooperative, probit analysis, soybean producers, tobit analysis

Biodiesel is a petroleum diesel replacement fuel made from renewable sources such as soybean oil, vegetable oils, or animal fats. Blends of up to 20% biodiesel and 80% petroleum diesel can be used in most diesel engines and generally do not require any engine modifications. Higher blends can be used in many engines built since 1994 with little or no modification. Currently the retail price differential between conventional diesel and a B20 blend (20% biodiesel) is in the 10% to 15% range [Alternative Fuels Data Center/Department of Energy (AFDC/DOE), 2003b]. Depending on the feedstock, cost estimates of producing biodiesel are two to three times that of wholesale diesel prices (Tareen, Wetzstein, and Duffield, 2000; Energy Information Administration/DOE, 2003). About 20 million gallons of biodiesel were produced in 2001, but U.S. capacity is already projected at 50 million gallons. Projections are that capacity will rise to between 60 and 80 million gallons over the next few years.

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Substituting petroleum diesel with biodiesel could decrease air emissions, reduce reliance on foreign oil, and help expand markets for U.S. farmers. Use of biodiesel in conventional diesel engines substantially reduces emissions of unburned hydrocarbons, carbon monoxide, sulfates, polycyclic aromatic hydrocarbons, nitrated polycyclic aromatic hydrocarbons, and particulate matter (AFDC/DOE, 2003a).

One potential means for soybean producers to capture the value-added is to forward integrate the processing of soybeans into biodiesel. A business structure that may be used to guarantee adequate supply of soybeans and raise capital for the processing facility is a New Generation Cooperative (NGC). New Generation Cooperatives share several characteristics with traditional cooperatives, such as one member/one vote and dividends based on patronage. However, NGCs exhibit some unique characteristics when compared to their traditional counterparts. First, delivery rights are tied to shares (obligation to deliver a unit of commodity). These shares may be purchased by producers to help fund construction of a processing facility. Second, NGCs have closed membership. Membership is comprised of producers who provide equity capital for the processing facility. Additional shares are not issued unless the processing facility is expanded. NGCs have formed in several industries, including a variety of food processing industries and bioenergy. For example, corn producers in the ethanol industry have used NGCs as a business structure.

In 2002/2003, Tennessee soybean producers expressed an interest in evaluating the feasibility of producing biodiesel from soybean oil in the state of Tennessee as a means to add value to their crop and to increase income. The results from that feasibility study suggested biodiesel could profitably be produced in Tennessee if Blender's Credits and Bioenergy Program payments were in place.[1] As a follow-up to the feasibility study, an analysis of producer interest in participating in an NGC to produce biodiesel was conducted. This study examines factors influencing soybean producers' willingness to participate in an NGC to produce biodiesel in Tennessee. Factors include farm and farm operator characteristics and views on biodiesel markets. The study also examines factors influencing the number of shares the producer would be willing to purchase. A probit model is used to estimate the decision of whether to join an NGC to produce biodiesel. The decision of how many shares to purchase in the NGC is estimated by a tobit model.

Prior Studies

Biodiesel Feasibility

Several studies have evaluated the feasibility of biodiesel production. VanWechel, Gustafson, and Leistritz (2003) found that without subsidies, production of biodiesel in North Dakota from soybean oil was not cost-competitive with conventional diesel

[1] USDA's Bioenergy Program reimburses participating bioenergy (commercial fuel grade ethanol and commercial biodiesel) producers for part of their costs of eligible commodities used in bioenergy production. The Blender's Credits provides tax credits for blending of biodiesel with conventional diesel.

prices. Findings from a study of biodiesel feasibility in Tennessee also suggested subsidies would be critical to the cost-competitiveness of biodiesel (English, Jensen, and Menard, 2002). Shumaker et al. (2003) studied economic feasibility of producing biodiesel in Georgia. Their results showed that biodiesel production was feasible without subsidies at feedstock prices of $0.10 per pound or less. Examining the feasibility of producing biodiesel from waste/recycled greases and animal fats, Groschen (2002) found yellow grease prices in Minnesota were about half that of soybean oil, and sufficient grease production existed to support about 4.5 to 6 million gallons of biodiesel production each year. Other studies have assessed the economic feasibility of producing biodiesel from beef tallow (Nelson and Schrock, 1994) and rapeseed (Van Dyne and Rayner, 1992).

New Generation Cooperatives

New Generation Cooperatives have been the focus of several studies. Carlberg, Holcomb, and Ward (2003) evaluated success factors for value-added NGCs. Important factors cited by corn processing/ethanol/energy cooperatives were having local champions or leaders, strong selling/marketing effort, full-time general managers, having a feasibility study, and adequate member capital base. From the results of their study examining investment decisions in NGCs, Puaha and Tilley (2003) reported that cooperative investment was positively influenced by full-time farming, but not by years of farming.

As found by Van Dyne and Blase (1998), Central Missouri soybean producers incurred large transactions costs in the conventional soybean marketing system. Their study suggested producers could increase their returns by participating in a New Generation Cooperative. Benefits could be increased by retained ownership. In particular, it was determined that producers who produce both soybeans and feed livestock, dairy, and/or poultry could benefit most by using both the high protein meal in feeding and the biodiesel for fuel on-farm as well as supplying soybeans to the plant.

Survey and Analysis Methods

Survey Data

In February of 2003, a mail survey was sent to 2,452 producers in Tennessee, based on a listing of soybean producers provided by the Tennessee Agricultural Statistics Service (TASS). All soybean farmers producing soybeans on at least 100 acres were surveyed. Among those producing on less than 100 acres, 20% were randomly selected and surveyed. Approximately two weeks after the initial mailing, a follow-up mailing was conducted in which a second copy of the survey was sent to all producers who had not yet responded. Of the 2,452 producer addresses, 40 were undeliverable. A total of 561 producers responded to the survey, for an overall response rate of 23.3%. Among those 561 producers, 276 answered all questions

Table 1. Soybean Farm Size Distribution: Tennessee Survey Respondents versus *1997 Census of Agriculture* Data

Farm Size in Soybean Acres	1997 U.S. Census of Agriculture			Tennessee Survey Respondents (%)
	Total No. of Farms	Using 20% of Smallest Farms		
		No. of Farms	% of Farms	
Less than 100	2,628	526	18.61	10.58
100 to 249	961	961	34.03	23.38
250 to 499	668	668	23.66	23.93
500 to 999	433	433	15.34	23.38
1,000 or more	236	236	8.36	18.74

necessary to be included in the statistical modeling. Therefore, the usable responses for the statistical modeling represented 11.3% of the deliverable surveys.

To assess how representative the responses were of soybean producers in Tennessee, several analyses were conducted. We did not have access to information about the nonrespondents other than their county location. However, characteristics of counties were compared across respondents versus nonrespondents to determine if county location might indicate disproportionate response in counties with more soybean farms or higher soybean yields. Using *t*-tests, no difference in average farm size or soybean yield was found across the respondents' counties compared with the nonrespondents' counties. The distribution of farm size of the respondents was then compared with the Tennessee farm size distribution from the *1997 Census of Agriculture* (U.S. Department of Agriculture, 1999). These results are shown in table 1. Note that for purposes of comparison, the Census numbers are adjusted to reflect 20% of the farms with less than 100 acres. From table 1, it can be seen that a higher percentage of the survey respondents fell into the larger acreage size categories than the share of farms in the Census. This suggests some nonresponse bias on the part of smaller soybean farms. However, it is also important to note that farm structure may have shifted since 1997. If historical trends are followed from 1997 to 2004, then the distribution of soybean farms is likely to have shifted toward larger farms.

The survey was comprised of three sections. The first section contained questions regarding soybean producers' views on biodiesel markets, including their views on growth potential for biodiesel markets and whether they would be willing to sell soybeans to a biodiesel processing facility. The second section focused on cooperative processing of soybeans into biodiesel. This section included questions about purchasing delivery shares in a cooperative and desired rates of return on investment in a cooperative to produce biodiesel. The third section of the survey included questions regarding characteristics of the soybean farm and the soybean producers' characteristics, including size of farm and experience of the farm operator.

Analysis Methods

Because this analysis examines the potential for an NGC, rather than studying existing members of an NGC, this study not only includes producers who indicated some willingness to participate in the NGC to produce biodiesel, but also some producers who are not interested in participating regardless of rate of return. Therefore, the models representing the participation decision for an NGC consist of two stages. First is the decision of whether the soybean producer is interested in participating in an NGC (probit model). Then, among the producers who are interested in participating in the NGC, we consider the decision of how many shares to purchase in the NGC (tobit model).

A probit model is used to estimate the decision of whether to join the NGC:

$$\Pr(JOIN = Yes) = \Phi(\boldsymbol{\beta}'\mathbf{X}), \tag{1}$$

where $\mathbf{X}$ is a matrix of the explanatory variables including farm characteristics, farm operator characteristics, and views on biodiesel; $\boldsymbol{\beta}$ is a vector of estimated parameters; and Φ is the normal distribution. For continuous explanatory variables, the effect of the variable on the probability of joining is specified as:

$$\partial \Pr[JOIN]/\partial \mathbf{X} = \phi(\boldsymbol{\beta}'\mathbf{X})\boldsymbol{\beta}, \tag{2}$$

where ϕ is the standard normal density. The effects of the discrete variables are found by calculating the probability of joining at the discrete values (for example, 0 or 1), holding all other variables at their means.

The definitions of the explanatory variables used in the probit model are presented in the upper portion of table 2. Producer demographics and views on biodiesel markets are hypothesized to have the majority of their effects on willingness to join the cooperative rather than the amount of shares. It was hypothesized that if soybean producers had more favorable views about the potential success of biodiesel markets, they would be more likely to be willing to participate (*JOIN*). Therefore, the *BIOD* variable is hypothesized to have a negative effect on the probability of being willing to participate. College graduates (*COLLEGE*) are postulated to be more likely to be willing to participate, while producers over age 65 (*AGE65*) are less likely to be willing to participate. Those over 65 may be considering full or partial retirement, and probably would not be as willing to make the long-term investment in shares for the processing facility requiring them to deliver soybeans. A biodiesel processing facility would rely on some on-site storage, but also on-farm storage. Producers who already had on-farm storage capabilities (*STORAGE*) are expected to be more likely to be willing to participate. Producers who are already members of a co-op, and sell some of their product through contracts, are likely more familiar with cooperative structures and have already been involved in contractual marketing arrangements (*COOPCONTR*). It is hypothesized that no farm debt (*NODEBT*) would have a positive influence on participation, because producers would not be obligated by as much debt and might be more willing to invest. If the

Table 2. Variable Names, Definitions, and Means

Variable Name	Definition	Mean
Probit Model (*N* = 276):		
JOIN	1 if producer is interested in joining NGC; 0 otherwise	0.7174
BIOD	Average of views on biodiesel market growth, importance to soybean markets, and willingness to use a 20% blend on producer's farming operation, 1–5 scale (1 = strongly agree, 5 = strongly disagree)	1.6359
COLLEGE	1 if producer is college graduate; 0 otherwise	0.3007
AGE65	1 if producer is at least age 65; 0 otherwise	0.1087
STORAGE	1 if producer has on-farm storage; 0 otherwise	0.7029
COOPCONTR	1 if producer is a cooperative member and has sold through marketing contracts; 0 otherwise	0.6304
NODEBT	1 if producer has no farm debt; 0 otherwise	0.3080
REGIONW	1 if soybean producer is located in West Tennessee region; 0 otherwise	0.1413
Tobit Model (*N* = 198):		
SHARES	Number of shares producer would be willing to purchase in NGC	3,456.5859
RETURN	Minimum rate of return producer would find acceptable on investment in biodiesel facility	9.5101
FARMINC1535	1 if net income from farming in 2001 = $15,000–$35,000; 0 otherwise	0.2424
FARMINC3550	1 if net income from farming in 2001 = $35,000–$50,000; 0 otherwise	0.1970
FARMINC5075	1 if net income from farming in 2001 = $50,000–$75,000; 0 otherwise	0.1616
FARMINCGT75	1 if net income from farming in 2001 = $75,000 or more; 0 otherwise	0.1869
OFF$FARM	1 if 50% or more of producer's income in 2001 came from off-farm sources; 0 otherwise	0.2879
COTTON	1 if producer raises cotton; 0 otherwise	0.2172
LIVESTOCK	1 if producer raises livestock; 0 otherwise	0.5505
REGIONW	1 if soybean producer is located in West Tennessee region; 0 otherwise	0.1515

producer was located in the West Tennessee counties, the region in the state of the highest soybean production, this was hypothesized to have a positive influence on probability of joining (*REGIONW*).

Puaha and Tilley (2003) propose the following investment function for a closed membership cooperative, x^i, such that:

$$x^{i(} \text{ ' } x^{i(}(R, G, \phi\mathbf{V}, p^i, W_0), \tag{3}$$

where x^i is investment in the closed cooperative, R is return on portfolio choice, G represents non-monetary benefits from choice, ϕ is the risk-aversion parameter, $\mathbf{V}$ is the variance/covariance matrix, p^i is price, and W_0 denotes initial wealth. In their analysis, the function for shares invested was estimated as a tobit model. Their analysis included shareholders only, with a minimum amount of 1,000 shares. A similar analysis is used for the respondents in this study who indicated willingness to participate in a New Generation Cooperative.

As with the Puaha and Tilley (2003) study, a tobit model is used to estimate the decision regarding how many shares to purchase (*SHARES*) in the NGC. The tobit model is expressed as follows:

$$\text{(4)} \qquad E\left[SHARES^{*}\mid \mathbf{Z}\right] = \Phi\left(\frac{\boldsymbol{\beta}'\mathbf{Z}}{\sigma}\right)\boldsymbol{\beta}'\mathbf{Z} + \sigma\lambda,$$

where

$$\lambda = \frac{\phi(\boldsymbol{\beta}'\mathbf{Z}/\sigma)}{\Phi(\boldsymbol{\beta}'\mathbf{Z}/\sigma)}.$$

The explanatory variables, including farm characteristics, farmer characteristics, views on biodiesel, and expected rate of return, are represented by the matrix **Z**. The vector of estimated parameters is **β**, and σ is the standard deviation. The effects of the continuous variables on the expected level of *SHARES* is found by:

$$\text{(5)} \qquad \partial E\left[SHARES^{*}\mid \mathbf{Z}\right]/\partial \mathbf{Z} = \boldsymbol{\beta}\Phi\left(\frac{\boldsymbol{\beta}'\mathbf{Z}}{\sigma}\right).$$

The effects of the discrete variables on *SHARES* are found by calculating the expected value of *SHARES* at each discrete value of the variable (such as 0 or 1), holding all other variables at their means. For the variables used in the tobit model, a listing of the variable names, definitions, and means is presented in the lower half of table 2. Note that because only those producers who indicated some interest in participating in the NGC are included in the *SHARES* model, the number of observations declines from 276 to 198.

In this study, respondents were asked the rate of return they required on the portfolio choice (investing in an NGC). A proxy for current wealth was farm income. While questions about risk perceptions were not asked directly, respondents were asked about off-farm income and diversification among crops and livestock. Region of the state was also included to examine any effects of the producer being located in the more concentrated soybean-producing region of West Tennessee.

It is hypothesized that financial measures, such as farm income, and the required returns will primarily impact the total number of shares, rather than the decision of whether to join. With an increase in the required rate of return (*RETURN*), the total number of shares (*SHARES*) is expected to increase. Higher levels of farm income (*FARMINC*) are hypothesized to have a positive influence on the number of shares producers would be willing to purchase. The effects of off-farm income (*OFF$FARM*) cannot be hypothesized a priori. Off-farm income could give a producer more financial resources to draw upon for investment; however, producers with significant off-farm income may not view soybean production income as their primary source of income and would not be willing to invest in processing facilities. This is also true for on-farm income diversification. If the producer raises cotton (*COTTON*) or livestock (*LIVESTOCK*), this could provide additional income sources; however, it might make producers less willing to concentrate their investments in soybean processing. Producers in the West Tennessee region (*REGIONW*), where

the higher producing soybean counties are located, are hypothesized to be willing to buy more shares.

Results

The estimated model for probability of interest in joining an NGC is displayed in table 3. Of the survey respondents, 276 answered all questions needed to conduct the statistical modeling. As can be seen from the log likelihood ratio (LLR) test, the model was significant overall. The model correctly classified 75.4% of the observations for *JOIN*. The variable *BIOD* had a negative influence on the probability of being willing to join. As the producers felt less positive about biodiesel markets, they were less likely to be willing to join an NGC to produce biodiesel. College educated producers were more likely to be willing to join, while producers over 65 were less likely to be willing to join. The effects of age as a continuous variable were investigated, but found to be insignificant. Therefore, other specifications such as age-squared and dummy variable specifications were examined. A dummy variable based on age over 65 was found to have a significant effect on probability of interest in joining. Producers with on-farm soybean storage were more likely to be willing to join than those without. Being a cooperative member who has sold soybeans through contracts did not have a significant effect. Producers with no farm debt were less likely to be willing to join than those with farm debt. Location in the West Tennessee region counties also did not have a significant effect. The marginal effects (change in probability of joining with a change in the variable) are displayed in the right-hand column of table 3.

Two profiles are compared to examine the effects on probability of being willing to participate. The first profile has a positive view about biodiesel markets, is college educated, under 65 years of age, has on-farm storage, is not debt free, is a cooperative member who sells through marketing contracts, and is located in the West Tennessee region. The second profile has a negative view about biodiesel markets, is not college educated, is over 65 years of age, does not have on-farm storage, is debt free, is not a cooperative member who sells through marketing contracts, and is not located in the West Tennessee region. When these two profiles are used with the estimated probit equation for *JOIN* (table 3), the probability of a producer of this profile being willing to join can be calculated. The first profile has a 98.03% chance of being willing to join, while the second profile has only a 4.3% chance of being willing to join.

The estimated tobit model for number of shares to be invested in the NGC is presented in table 4. The average number of shares in which interested producers would invest was about 3,456. However, over 61% were only willing to invest in 2,500 shares or less. Approximately 31% of the producers were willing to make a 2,500–5,000 share investment, while only 8% were willing to invest in at least 5,000 shares. The model was significant overall, as indicated by the results from the LLR test. Greater expected minimal returns from investment in an NGC biodiesel facility had a negative influence on shares the producer was willing to invest. Compared

Table 3. Probit Model for Probability of Being Interested in Joining an NGC to Produce Biodiesel (*N* = 276)

Variable	Estimated Coefficient	Standard Error	Marginal Effect
Intercept	0.3220	0.3543	
BIOD	!0.2549*	0.1586	!0.0808
COLLEGE	0.8154***	0.2132	0.2265
AGE65	!0.4093*	0.2679	!0.1421
STORAGE	0.6933***	0.1871	0.2360
COOPCONTR	0.2594	0.1845	0.0840
NODEBT	!0.3565*	0.1939	!0.1177
REGIONW	0.2232	0.2708	0.0667
LLR Test (χ^2)	= 52.3696***		
% Correctly Classified	= 75.3623		

Notes: Single, double, and triple asterisks (*) denote statistical significance at the10%, 5%, and 1% levels, respectively. LLR is Log Likelihood Ratio.

Table 4. Tobit Model for Number of Shares Willing to Invest in NGC to Produce Biodiesel (*N* = 198)

Variable	Estimated Coefficient	Standard Error	Marginal Effect
Intercept	2,916.4609***	806.942	
RETURN	!60.5999*	40.388	!49.9958
FARMINC1535	842.0361	763.200	695.1500
FARMINC3550	1,415.3813*	804.441	1,168.4800
FARMINC5075	1,545.7245*	835.417	1,276.0859
FARMINCGT75	1,398.8007*	833.456	1,154.7918
OFF$FARM	!1,242.4760**	572.061	!1,025.7366
COTTON	861.4680	615.653	711.1925
LIVESTOCK	426.6160	519.633	352.1961
REGIONW	!1,211.6200*	706.446	!1,000.2625
Sigma (σ)	3,432.3600***	187.375	
LLR Test (χ^2) = 17.993*			

Notes: Single, double, and triple asterisks (*) denote statistical significance at the10%, 5%, and 1% levels, respectively. LLR is Log Likelihood Ratio.

with the lowest farm income level (less than $15,000), income levels of $35,000 and greater had a positive effect on the number of shares a producer would be willing to invest in. Location in the West Tennessee counties area had a negative effect on shares. Having 50% or more of income from off-farm sources had a negative influence on shares. Neither livestock nor cotton production had significant effects.

The projected number of shares is estimated for two profiles. The first profile requires a 7% return, has farm income of $50,000 to $75,000, does not derive at least 50% of income from off-farm sources, is not located in the West Tennessee region, and also produced livestock and cotton. The second profile requires a 12% return, has farm income of $15,000 to $35,000, 50% or more of income is derived from off-farm sources, is not located in the West Tennessee region, and also produced livestock and cotton. These two profiles are used with the estimated parameters from table 4 in the formula shown in equation (4) to calculate the projected number of shares. For the first profile, the projected number of shares is 5,442, while the projected number of shares for the second profile is 2,752.

Conclusions

The results from this study suggest many soybean producers (over 70% in the study group) are interested in the possibility of investing in an NGC to produce biodiesel. Some caution should be used, however, because the respondents tended to farm larger acreages than the Tennessee state average. This could have increased the percentage of producers who were interested in participating, as well as the number of shares to be sold. Also, it is possible that those producers with some interest in biodiesel or New Generation Cooperatives were more likely to respond to the survey than those lacking interest. If it is assumed that producers who did not respond had little interest in biodiesel or NGCs, then the percentage interested in participating could be as low as 16–17% (i.e., 23.3% overall response rate multiplied by 71.7% interested).

Based on the findings of this analysis, producers who have more favorable views of biodiesel markets and who are likely to be interested in participating in an NGC are college educated, less than 65 years old, already have on-farm storage, and carry some debt. Among those producers willing to participate in an NGC, the average number of shares they would purchase was just under 3,460. The level of farm income is an important influence on the number of shares a producer is willing to purchase. Producers who rely on off-farm sources for the majority of their income will likely purchase fewer shares than those with higher farm incomes and little reliance on off-farm income. Interestingly, producers indicating a higher rate of return required to invest in an NGC were willing to invest in fewer shares. This result could reflect higher risk aversion on the part of these producers—an interpretation confirmed by our finding that debt-free producers were less likely to be interested in investing.

The scope of this study was limited to Tennessee soybean producers. Much of the state's soybean production lies in West Tennessee. Because significant soybean production also occurs in Southeast Missouri and Southwest Kentucky, future research should expand this analysis to include those regions.

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