# Assessing the Impacts of Soil Carbon Credits and Risk on No-Till Rice Profitability

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**Abstract**

Rice is a major cash crop in eastern Arkansas, but most rice acres are intensively cultivated and grown on rented land. No-till is an effective means of sequestering soil carbon and reducing greenhouse gas emissions, and economic incentives exist for no-till in the form of carbon credits. Studies evaluating the economic potential of carbon credits focus on producers only and do not take into consideration the landlord's perspective. This analysis evaluates the profitability and risk efficiency of no-till management and carbon credits in Arkansas rice production from the prospective if the landlord using simulation and stochastic efficiency with respect to a function (SERF). The results indicate carbon credits may have potential to enhance preference for no-till in rice production by risk-averse landlords.

Key Words: certainty equivalent, landlord, no-till, rice, risk premium

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**Introduction**

Arkansas is the top rice producing state in the U.S. and accounts for nearly one-half of total U.S. rice production (USDA ERS 2007b). Nearly all rice production occurs in the eastern part of the state in the Mississippi Alluvial Valley. Surface water quality in this region is significantly influenced by geography, climate, and agriculture. The area has little topographic relief, and soils are predominantly composed of dense alluvial clay sub-soils that limit water infiltration (Kleiss et al.). Surface soils contain little organic matter and are comprised of silt and clay particles that are readily transported by runoff from tilled fields during heavy rainfall events (Huitink et al.). Sediment is the primary pollutant identified for most eastern Arkansas waterways (ADEQ; Huitink et al.), and conservation practices like no-till are commonly recommended as remedial mechanisms (Huitink et al.).

The economics of no-till rice have been investigated using both partial budget analysis (Pearce et al.; Smith and Baltazar; Watkins, Anders, and Windham) and whole-farm analysis (Watkins et al.). However, these studies evaluate no-till profitability from the prospective of the producer only. Most farmland under cultivation in eastern Arkansas is owned by someone other than the producer. In 2002, tenants accounted for 28% of farmland acres, while part owners (farmers who own and rent farmland) accounted for 48% of farmland acres in eastern Arkansas. Moreover, 70% of eastern Arkansas farmland acres operated by part owners were rented in 2002 (USDA, NASS, 2002). These statistics implicitly highlight the influence of landlords in eastern Arkansas agriculture. A recent economic study of no-till rice and rental arrangements indicated that expected returns and risk premiums to no-till are large for tenants but marginal for landlords on rented land (Watkins, Hill, and Anders). Thus, landlords may be largely indifferent in their preference between no-till and conventional till in rice production.

No-till management is an effective means of sequestering soil carbon and reducing greenhouse gas emissions, and economic incentives exist for no-till in the form of carbon credits. The Chicago Climate Exchange (CCX) trades carbon credits and allows agricultural landowners to receive annual payments per metric ton of carbon sequestered for land devoted to no-till management for a five-year contract period (Ribera, Zenteno, and McCarl). Recent economic studies evaluating carbon sequestration and no-till management indicate that carbon credits would not be necessary to entice risk-averse managers to adopt no-till if no-till already produces larger net returns than conventional tillage (Pendell et al. 2006, 2007). However, these studies evaluate the economic potential of carbon credits as an incentive for producers only and do not take into consideration the landlord's perspective if the land in question is leased.

The objective of this study is to determine the value of carbon credits necessary to provide landlords with economic incentive to adopt no-till rice on rented land. Profitability and risk efficiency of no-till rice and carbon credits will be evaluated for landlords using simulation and stochastic efficiency with respect to a function (SERF). Stochastic yield and price distributions are simulated for a typical two-year rice-soybean rotation using data from a long-term cropping systems study near Stuttgart, Arkansas and secondary price data from the USDA. Landlord net return distributions are constructed for popular rental arrangements in eastern Arkansas rice production with and without carbon credits. Carbon credit prices that encourage adoption of no-till are defined as the minimum prices necessary to promote preference for no-till by landlords exhibiting risk aversion.

## Data and Methods

***Rental Arrangements.*** Rental arrangements in eastern Arkansas can be grouped into three classifications: 1) crop share arrangements; 2) cost share arrangements; and 3) fixed cash arrangements (Bierlen and Parsch; Rainey et al.). Most rental arrangements in Arkansas rice production are crop share arrangements in which the landlord receives a share of the crop and government payments, and the tenant pays nearly all expenses related to crop production (Parsch and Danforth). The only expense items shared in crop share arrangements are drying and irrigation expenses. Drying expenses are shared in the same proportion as the crop. Irrigation expenses are split into above and below ground expenses, with the tenant paying all above ground expenses associated with the irrigation power unit and the landlord paying all below ground expenses associated with the well, pump, and gearhead. The typical split for crop share arrangements is 75/25, with the landlord receiving 25% of the crop and government payments. However, 80/20 crop share arrangements also exist in Arkansas rice production.

Cost share arrangements are common in Arkansas rice production, although less frequent than crop share arrangements. The typical split for these arrangements is 50/50 (Parsch and Danforth). The landlord receives 50% of the rice crop and government payments in exchange for sharing 50% of seed, pesticide, and fertilizer variable expenses. The landlord also pays 100% of all irrigation expenses with the exception of irrigation labor, which is supplied by the tenant. Cost share arrangements are less frequent for soybeans than for rice. Thus cost share arrangements in this analysis are modeled for the rice portion of the rotation only, with crop share arrangements modeled for soybeans.

Fixed cash arrangements are less common than crop share arrangements in Arkansas rice production (Parsch and Danforth). In a fixed cash arrangement, the tenant pays the landlord a fixed rate for the use of the land and is responsible for all other production expenses except those associated with below ground irrigation. The tenant receives 100% of the crop and government payments. Rice and soybean cash rents used in the analysis were obtained from 2001 average rents reported in Hill et al. Cash rents were adjusted to 2007 dollars using the Producer Price Index. The resulting cash rents were $122 per acre for rice and $84 per acre for irrigated soybeans.

The rental arrangements modeled for this analysis are as follows:

1. 75/25 Crop share (R75S75)
2. 80/20 Crop share (R80S80)
3. 50/50 Rice Cost Share - 75/25 Soybean Crop Share - (R50S75)
4. 50/50 Rice Cost Share - 80/20 Soybean Crop Share - (R50S80)
5. Fixed Cash (CASH)

where R = rice; and S = Soybean.

***Simulated net returns.*** Landlord rice-soybean rotation net returns were simulated by iteration, tillage treatment, and rental arrangement using the following equation:

$$(1)\quad LNR_{ijk} = 0.5 \cdot \sum_{l=1}^{2} S_{kl} \cdot [Y_{ijl} \cdot (P_{il} + LDP_{il} - D_l) + DP_l + CCP_{il}] + C_l - LVE_{kl} - LFE_{kl}$$

where $i$ = 1 to 500 iterations; $j$ = 1 to 2 tillage treatments (no-till, conventional till); $k$ = 1 to 5 rental arrangements as defined above; $l$ = 1 to 2 crops (rice, soybean); $S_{kl}$ is the landlord's share of the crop and government payments for rental arrangement $k$ and crop

$l$; $Y_{ijl}$ is the simulated yield of crop $l$ for tillage treatment $j$ and iteration $i$ (bushels per acre); $P_{il}$ is the simulated farm price for crop $l$ and iteration $i$ ($ per bushel); $LDP_{il}$ is the loan deficiency payment for crop $l$ and iteration $i$ ($ per bushel); $D_l$ is the drying charge for crop $l$ ($ per bushel); $DP_l$ is the direct payment for crop $l$ ($ per acre); $CCP_{il}$ is the counter-cyclical payment for crop $l$ and iteration $i$ ($ per acre); $LVE_{kl}$ is the landlord's variable expenses for rental arrangement $k$ and crop $l$ ($ per acre); $LFE_{kl}$ is the landlord's fixed expenses for rental arrangement $k$ and crop $l$ ($ per acre); and $C_l$ is the fixed cash rent for crop $l$ ($ per acre).

***Government payments.*** Government payments for the study were calculated assuming the continuation of the Farm Security and Rural Investment Act of 2002 (hereafter referred to as the 2002 Farm Bill). Simulated loan deficiency payments for rice and soybean are calculated as follows:

$$(2)\quad LDP_{il} = Max[(LR_l - \tilde{P}_{il}),0]$$

where $LR_l$ equals the loan rate for crop $l$ ($ per bushel) and $\tilde{P}_{il}$ equals either the simulated world market rough rice price or the simulated season average Arkansas soybean price ($ per bushel), depending on the crop of interest. The $LR_l$ used for rice and soybeans, respectively was $2.93 and $5.00 per bushel as per the 2002 Farm Bill.

Direct payments ($DP_l$) are calculated for each crop as follows:

$$(3)\quad DP_l = 0.85 \cdot DPY_l \cdot DPR_l$$

where $DPR_l$ and $DPY_l$ are the direct payment rate ($ per bushel) and the direct payment yield (bushels per acre) for crop $l$. The $DPR_l$ used for rice and soybean, respectively, was $1.06 and $0.44 per bushel as per the 2002 Farm Bill. The $DPY_l$ used for rice and soybean, respectively, was 108.9 and 25.7 bushels per acre. Direct payment yields for rice and soybeans represent averages obtained from six Arkansas representative panel farms growing both rice and irrigated soybeans (Hignight).

Simulated counter-cyclical payments ($CCP_{il}$) were calculated as follows:

$$(4)\ CCP_{il} = 0.85 \cdot CCPY_l \cdot Max[TP_l - (DPR_l + Max\{SAFP_{il}, LR_l\},0]$$

where $TP_l$ is the target price for crop $l$ ($ per bushel), $SAFP_{il}$ is the simulated national season average farm price for iteration $i$ and crop $l$ ($ per bushel), $CCPY_l$ is the counter cyclical payment yield for crop $l$ (bushels per acre), and $DPR_l$ is as defined above. The $TP_l$ used for rice and soybean, respectively was $4.73 and $5.80 per bushels as per the 2002 Farm Bill. The $CCPY_l$ used for rice and soybean, respectively, was 122.6 and 33.2 bushels per acre, and represent averages obtained from six Arkansas representative panel farms growing both rice and irrigated soybeans (Hignight).

***Carbon credits***. Carbon credits for this study were calculated using the following formula:

$$(5)\ CARBC = CARB(P_{CARB} - 0.08P_{CARB} - 0.20 - 0.12)$$

where $CARBC$ = per acre carbon credit net of an aggregation fee (8% of CCX price), a CCX registration and trading fee ($0.20 per metric ton), and a verification fee ($0.12 per metric ton); $P_{CARB}$ = the CCX carbon credit price ($ per metric ton); and $CARB$ = the CCX annual carbon sequestration rate (metric tons per acre). The aggregation fee is charged by the aggregator to complete the enrollment paper work required by the CCX[1]. The verification fee is charged to all landowners participating in the program to pay for a third party to verify that correct procedures to sequester carbon are being followed (Ribera, Zenteno and McCarl). The value for $CARB$ in this study was set to 0.6 metric

[1] An aggregator is a go-between party that interfaces landowners with the CCX. Aggregators accept initial registrations and trade carbon credits on the CCX on behalf of landowners.

tons per acre as per the CCX carbon sequestration rate specified for Zone A of the CCX Conservation Tillage Soil Offset Map.

Although not specified in equation 5, the CCX or aggregator typically sets aside 20% of the annual carbon credits from every project as an insurance pool to protect against any carbon storage reversal that might occur due to unfortunate events such as fires, hurricanes, etc. (Ribera, Zenteno and McCarl). The maximum amount of storage reversal a project owner could face is the amount withheld in the retention pool. The amount of carbon set aside in the retention pool is paid back to the landowner during the last year of the five-year contract. Equation 5 assumes the landowner receives the entire carbon credit with the 20% carbon retention released in year 5 of the contract.

***Simulated yields and prices.*** SIMETAR, developed by Richardson, Schumann, and Feldman was used to simulate yield and price distributions in the study. Multivariate empirical distributions (MVEs) were used to simulate 500 iterations of yields and prices. A MVE distribution simulates random values from a frequency distribution made up of actual historical data and has been shown to appropriately correlate random variables based on their historical correlation (Richardson, Klose, and Gray). Parameters for the MVE include the means, deviations from the mean or trend expressed as a fraction of each variable, and the correlation among variables. The MVE distribution is used in instances where data observations are too few to estimate parameters for another distribution (Pendell et al.).

Rice and soybean yield distributions under conventional till (CT) and no-till (NT) were simulated using seven years of historical yield data from a long term rice-based cropping systems study at Stuttgart, AR for the period 2000-2007 (Anders et al.). The historical crop yields represent yields obtained in a two-year rice-soybean rotation. Deviations from the 8-year means were used to estimate the parameters for the MVE yield distributions. The mean yield values over the 8-year period were used as the expected yields for the MVE yield distributions. Summary statistics for the simulated yields are presented in Table 1.

Price distributions were simulated using season average Arkansas rice and soybean price data (USDA NASS 2008a,b), world market rice price data (USDA ERS 2007b), and national average rice and soybean price data (USDA, ERS 2007a) for the period 2000-2007. The season average world market rice price for each year was determined by averaging observations from August 15 through October 31 of each year. Deviations from the 8-year means were used to estimate the parameters of the MVE price distributions. Prices for 2007 were used as expected prices rather than the 8-year historical means for the MVE price distributions, since prices for 2007 better represent current farmer price expectations. The MVE approach has been shown to reproduce the historical correlation matrix and maintain the historical coefficient of variation from the original historical data series even when using means different from the historical mean (Ribera, Hons, and Richardson). Summary statistics for simulated prices are presented in Table 1.

***Risk analysis.*** Rental arrangements are ranked for landlords and tenants according to risk attitudes using stochastic efficiency with respect to a function (SERF). The SERF method is a variant of stochastic dominance with respect to a function (SDRF) that orders a set of risky alternatives in terms of certainty equivalents (CE) calculated for specified ranges of risk attitudes (Hardaker et al.). A certainty equivalent (CE) is equal to the amount of certain payoff an individual would require to be indifferent between that payoff and a risky investment. The CE is typically less than the expected (mean) monetary value and greater than or equal to the minimum monetary value of a stream of monetary outcomes (Hardaker et al.). The SERF method allows for simultaneous rather than pairwise comparison of risky alternatives and can in some instances produce a smaller efficient set than conventional SDRF (Hardaker et al.). Graphical presentation of SERF results facilitates the presentation of ordinal rankings for decision makers with different risk attitudes and provides a cardinal measure of a decision maker's conviction for preferences among risky alternatives at each risk aversion level by interpreting differences in CE values for a given risk aversion level as risk premiums (Hardaker et al.).

The SERF method calls for calculating CE values over a range of absolute risk aversion coefficients (ARACs). The ARAC represents a decision maker's degree of risk aversion. Decision makers are risk averse if ARAC > 0; risk neutral if ARAC = 0, and risk preferring if ARAC < 0. The range of ARAC values used in this analysis was from 0 (risk neutral) to 0.024 (strongly risk averse). The latter value was calculated using the formula proposed by Hardaker et al. of $r_a(w) = r_r(w)/w$, where $r_a(w)$ = absolute risk aversion with respect to wealth (w), and $r_r(w)$ = relative risk aversion with respect to wealth. In this analysis, $r_r(w)$ was set to 4 (very risk averse) as proposed by Anderson and Dillon, and w equals the landlord's average net return across alternative rental arrangements in Table 2 of $165 per acre (Hardaker et al.).

The SERF procedure in SIMETAR is used to calculate CE values by rental arrangement for the landlord ARAC ranges specified above. A negative exponential utility function is used to calculate CE values (Hardaker et al.). A landlord CE graph is constructed to display ordinal rankings of rental arrangements across the specified range of ARAC values. No-till risk premiums are also mapped for each rental arrangement across ARAC values with and without a specified net carbon credit at the 2007 average CCX carbon credit price across vintages of $3.18 per metric ton.

**Results and Discussion**

Summary statistics of simulated landlord net returns by rental arrangement and tillage method are presented in Table 2. Average returns to the landlord are approximately equal for no-till relative to conventional till management for every rental arrangement analyzed in the study. Therefore, risk-neutral landlords desiring to maximize expected returns would be indifferent as to whether the tenant used NT or CT on rented land. The NTR50S75 and CTR50S75 arrangements have the largest average net return for the landlord ($207 and $209 per acre, respectively), while the CASH arrangement produces the smallest average net return for the landlord ($87 per acre). Landlord return variability is slightly smaller for NT than for CT for all rental arrangements evaluated with the exception of CASH. The NTR80S80 and CTR80S80 arrangements are the least desirable crop share arrangements for the landlord. Both arrangements result in the largest probabilities of receiving a net return lower than cash rent (12% for NTR80S80; 13% for CTR80S80).

Landlord SERF results are presented across the ARAC range of 0 (risk neutral) to 0.024 (strong risk aversion) in Figure 1. Strategies that are risk preferred in Figure 1 have the locus of points of highest CE values (Hardaker et al.). The NTR50S75 and the CTR75S25 arrangements are the preferred strategies for the landlord, followed closely by the NTR50S80 and CTR50S80 arrangements. These arrangements allow the landlord to receive a larger share of the rice crop and rice government payments relative to the other rental arrangements evaluated. The CASH arrangement is the least preferred by the landlord, followed by the NTR80S80 and CTR80S80 arrangements. Rental arrangements using NT management tend to be slightly more dominant than those using CT management as ARAC values increase (e.g., as risk aversion becomes greater). However, the preference for NT by risk-averse landlords is relatively small in magnitude as is evident by the relatively narrow gaps between NT and CT certainty equivalents for increasing ARAC values in Figure 1.

Landlord no-till risk premiums are presented by rental arrangement over the ARAC range of 0 to 0.024 in Figure 2. The mapping of risk premiums across ARAC values demonstrates the relative indifference between NT and CT that would likely be exhibited by risk-averse landlords. No-till risk premiums are modest at best and are negative for all rental arrangements across at least part of the specified ARAC range. Note that the no-till risk premium for CASH is zero since the amount of return the landlord receives is fixed across tillage treatments for this arrangement.

Landlord no-till risk premiums with a net carbon credit calculated at the 2007 average CCX carbon credit price of $3.18 per metric ton are presented by rental arrangement over the ARAC range of 0 to 0.024 in Figure 3. The net carbon credit equals $1.56 per acre at the 2007 CCX average price and is also mapped in Figure 3. This carbon credit alone would represent the no-till risk premium for the CASH arrangement, as it would denote an additional payment to the landlord above the fixed cash rent. The net carbon credit shifts the no-till risk premium line upward for every rental strategy and makes no-till more attractive to risk-averse landlords as ARAC values increase. All but the R50S80 arrangement have positive no-till risk premiums across the entire specified range of ARAC values when adding the $1.56 per acre net carbon credit.

Carbon credits and derived CCX carbon credit prices necessary to ensure positive no-till risk premiums for risk-averse landlords are presented by rental arrangement in Table 3. Net carbon credits in Table 3 are calculated as the difference in mean simulated return under conventional till and the mean simulated return under no-till for each rental arrangement. Based on these net carbon credit values, the derived CCX prices necessary to ensure positive no-till risk premiums for a risk-averse landlord ranges from $0.54 per metric ton for R80S80 to $3.99 per metric ton for R50S80 assuming the landlord receives the entire credit. If the landlord shares the carbon credit with the tenant in equal proportion to each crop, the CCX prices necessary to ensure positive no-till risk premiums for the risk-averse landlord ranges from $1.30 per metric ton for R80S80 to $10.76 per metric ton for R50S80. These values compare to the 2007 average CCX carbon credit price of $3.18 per metric ton.

**Summary and Conclusions**

This analysis evaluated the profitability and risk efficiency of no-till management and carbon credits in Arkansas rice production from the prospective of the landlord using simulation and stochastic efficiency with respect to a function (SERF). Crop yields and prices were simulated for a typical two-year rice-soybean rotation using multivariate empirical distributions (MVEs). Landlord net return distributions were constructed for popular rental arrangements used in Arkansas rice production, and risk premiums to no-till management were evaluated both with and without carbon credits. The landlord's perspective was evaluated because the majority of cropland farmed in eastern Arkansas is owned by someone other than the producer.

The results indicate that carbon credits, even of a modest nature, would enhance a risk-averse landlord's preference for no-till management in rice production. The carbon credits necessary to ensure positive no-till risk premiums for risk-averse landlords ranged from $0.11 per acre to $2.01 per acre, and their corresponding derived CCX prices ranged from $0.68 per metric ton to $3.99 per metric ton. Derived CCX carbon credit prices necessary to ensure positive no-till risk premiums for risk-averse landlords would need to be greater if the landlord shares the carbon credit with the tenant in the same proportion as each crop is shared and would range from $1.67 per metric ton to $10.76 per metric ton based on this analysis. The CCX carbon credit price for 2007 averaged $3.18 per metric ton across all vintages and ranged from $1.65 to $4.20 per metric ton.

These results indicate some potential may exist for targeting carbon credits towards landlords as a means of inducing adoption of no-till rice on rented land. This potential would likely be enhanced if society decides to regulate green house gas emissions with some type of mandatory cap-and-trade program, whereby carbon credit prices would likely increase.

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Table 1. Summary Statistics of Simulated Yields and Prices.

| Variable | Mean [a] | SD | CV [b] | Minimum | Maximum |
|---|---|---|---|---|---|
| NT Rice Yield (bu/acre) [c] | 177.74 | 14.74 | 8.30 | 160.46 | 209.01 |
| CT Rice Yield (bu/acre) | 184.31 | 15.32 | 8.31 | 154.73 | 204.59 |
| NT Soybean Yield (bu/acre) | 48.05 | 9.92 | 20.64 | 36.04 | 68.22 |
| CT Soybean Yield (bu/acre) | 45.18 | 16.35 | 36.20 | 13.80 | 67.76 |
| Arkansas Rice Farm Price ($/bu) | 4.96 | 1.63 | 32.85 | 2.77 | 7.75 |
| Arkansas Soybean Farm Price ($/bu) | 9.81 | 2.40 | 24.47 | 6.87 | 15.41 |
| Rice World Market Price ($/bu) | 3.52 | 1.18 | 33.58 | 2.17 | 5.49 |
| National Rice Farm Price ($/bu) | 5.77 | 2.07 | 35.94 | 3.25 | 9.80 |
| National Soybean Farm Price ($/bu) | 10.40 | 2.89 | 27.76 | 7.29 | 17.30 |

[a] Summary statistics calculated from 500 simulated iterations.

[b] Coefficient of Variation (CV) is a unitless measure of relative risk and is equal to the standard deviation (SD) divided by the mean.

[c] NT = No-Till; CT = Conventional till.

Table 2. Summary Statistics of Simulated Landlord Net Returns by Rental Arrangement and Tillage Method.

| Arrangement | Mean [a] | SD | CV [b] | Minimum | Maximum | Prob. NR < C [c] |
|---|---|---|---|---|---|---|
| | -----------$/acre----------- | | | ------------$/acre------------ | | |
| NTR75S75[d] | 166 | 47 | 28.5 | 93 | 298 | 0% |
| CTR75S75 | 166 | 51 | 30.3 | 74 | 313 | 2% |
| NTR80S80 | 130 | 38 | 29.2 | 71 | 235 | 12% |
| CTR80S80 | 130 | 40 | 31.1 | 56 | 247 | 13% |
| NTR50S75 | 207 | 79 | 38.1 | 79 | 410 | 0% |
| CTR50S75 | 209 | 81 | 39.0 | 55 | 430 | 2% |
| NTR50S80 | 195 | 76 | 39.0 | 71 | 391 | 1% |
| CTR50S80 | 197 | 78 | 39.5 | 50 | 404 | 4% |
| CASH | 87 | 0 | 0.0 | 87 | 87 | 0% |

[a] Summary statistics calculated from 500 simulated iterations.

[b] Coefficient of Variation (CV) is a unitless measure of relative risk and is equal to the standard deviation (SD) divided by the mean.

[c] Probability of receiving a net return less than cash rent.

[d] NT = No-Till; CT = Conventional Till; R = Rice portion of rotation; S = Soybean portion of rotation; 75, 80, 50 = tenant's share of the crop in crop/cost share arrangement; CASH = fixed cash arrangement.

Table 3. Carbon Credits and Derived CCX Carbon Credit Prices Necessary to Ensure Positive No-Till Risk Premiums for Risk-Averse Landlords by Rental Arrangement.

| Rental Arrangement | Net Carbon Credit ($/acre) [a] | Derived CCX Price, Landlord Receives Entire Credit ($/MT) [b] | Derived CCX Price, Landlord Shares with Tenant ($/MT) [b] |
|---|---|---|---|
| R75S75 [c] | 0.18 | 0.68 | 1.67 |
| R80S80 | 0.11 | 0.54 | 1.30 |
| R50S75 | 1.34 | 2.78 | 6.84 |
| R50S80 | 2.01 | 3.99 | 10.76 |

[a] Difference in the mean simulated return for the rental arrangement under conventional till and the mean simulated return under no-till management.
[b] Average CCX carbon credit price for 2007 across all vintages equals $3.18/MT. At this price, the net carbon credit would equal $1.56/acre assuming a carbon sequestration rate of 0.6 MT/acre, an aggregation fee of 8% the CCX price, a registration and trading fee of $0.20/MT, and a verification fee of $0.12/MT.
[c] R = Rice portion of rotation; S = Soybean portion of rotation; 75, 80, 50 = tenant's share of the crop in crop/cost share arrangement.

**Figure 1. Landlord SERF Results Over Absolute Risk Aversion Range of 0.000-0.024 Assuming Negative Exponential Utility Function**

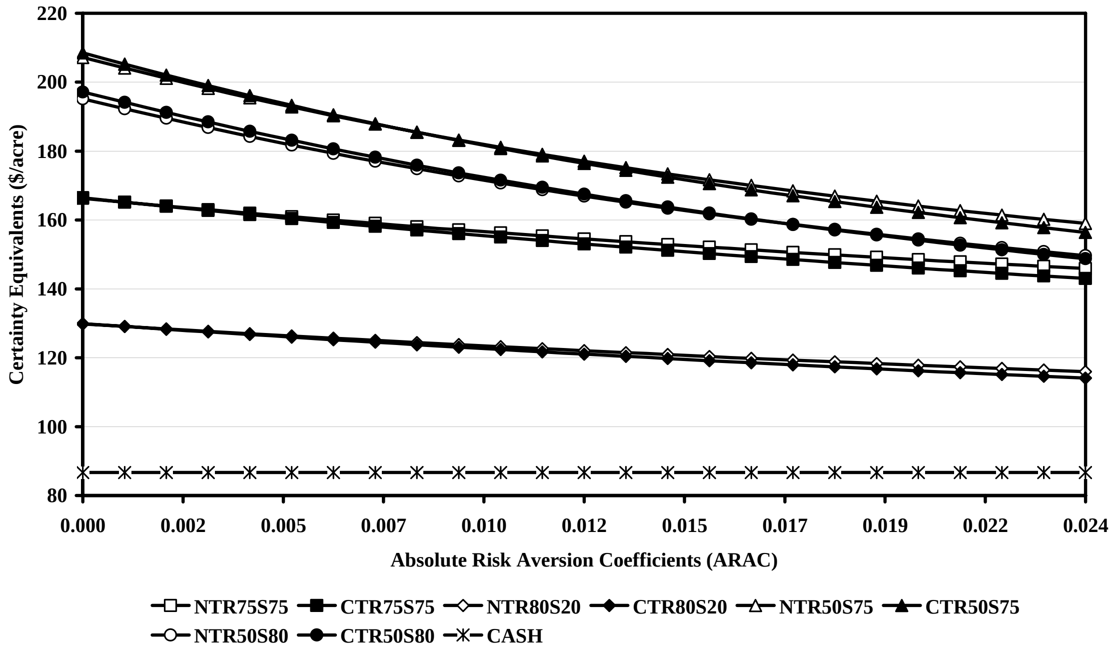

**Figure 2. Landlord No-Till Risk Premiums by Rental Arrangement Over Absolute Risk Aversion Range of 0.000-0.024 Assuming Negitive Exponential Utility Function**

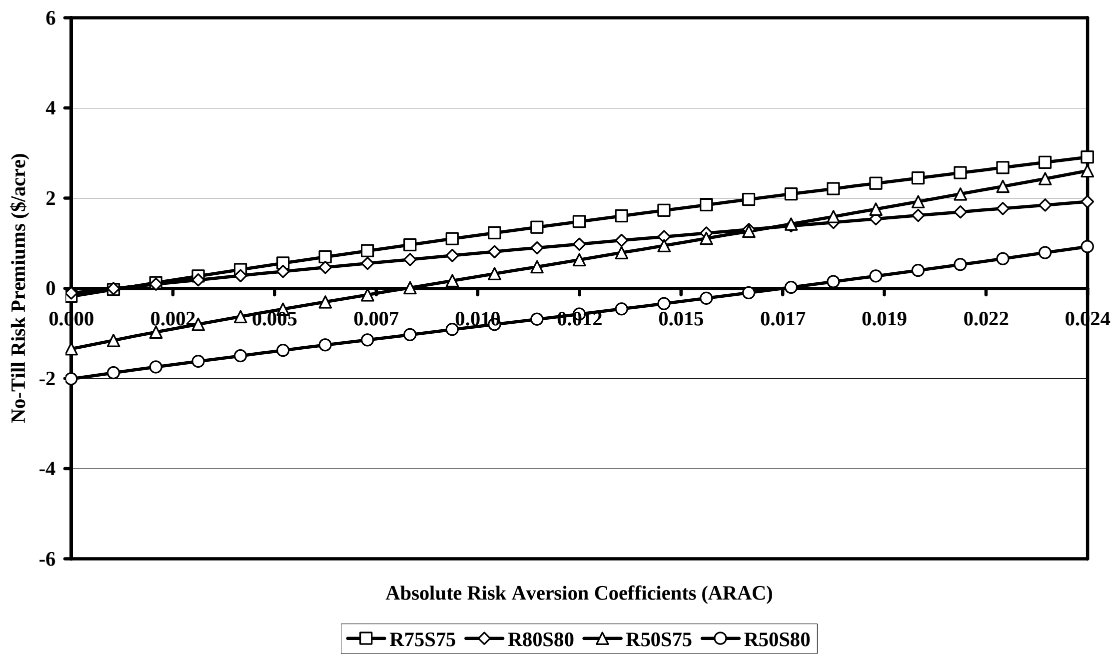

**Figure 3. Landlord No-Till Risk Premiums With Net Carbon Credit at the 2007 Average CCX Price of $3.18/MT by Rental Arrangement Over Absolute Risk Aversion Range of 0.000-0.025 Assuming Negative Exponential Utility Function**