Risk and Return for Bioenergy Crops under Alternative Contracting Arrangements

by

James A. Larson, Associate Professor
Department of Agricultural Economics
The University of Tennessee
308G Morgan Hall, 2621 Morgan Circle
Knoxville, TN 37996-4518
Phone: 865-974-3716
Email: jlarson2@utk.edu

Burton C. English, Professor
Department of Agricultural Economics
The University of Tennessee
308C Morgan Hall, 2621 Morgan Circle
Knoxville, TN 37996-4518
Phone: 865-974-3716

Lixia He, Post Doctorial Research Associate
Agricultural Policy Analysis Center
The University of Tennessee,
310 Morgan Hall 2621 Morgan Circle
Knoxville, Tennessee 37996-4519.

Selected Paper prepared for presentation at the
Southern Agricultural Economics Association Annual Meetings
Dallas, TX February 2-6, 2008.

Risk and Return for Bioenergy Crops under Alternative Contracting Arrangements

Abstract

This study evaluated the potential to supply biomass feedstocks under alternative contract arrangements for a northwest Tennessee 2,400 acre grain farm. The four potential types of contracts analyzed in this study offer different levels of biomass price, yield, and production cost risk sharing between the representative farm and the processor.

Risk and Return for Bioenergy Crops under Alternative Contracting Arrangements

Introduction

Farmers, agribusiness, policymakers, and others have shown considerable interest in the potential for on-farm production of biomass for ethanol production (English et al, 2006). The potential volume of ethanol produced from cellulosic sources such as wheat straw, corn stover, and switchgrass is much greater than the potential volume of ethanol from corn grain (Epplin etal., 2007). Perlack et al. (2005) estimates that more than a billion tons of cellulosic feedstock could be produced annually in the United States. Compared to other agricultural commodities, transportation costs from grower to processor for cellulosic feedstocks will be relatively high, due to their bulkiness and low energy densities. This transportation cost factor will likely result in a more locally-grown market situation for biomass feedstock. Thus, the development of biobased industries, at least initially, will hinge on the local availability of sufficient, cost competitive biomass feedstocks.

Given the high cost of constructing a production facility, the processor likely will have an interest in providing contracts or other incentives to induce farmers to supply sufficient feedstocks to keep the plant operating at capacity. One possible alternative for supplying biomass to the processor is a vertically integrated system where the plant leases (or purchases) agricultural lands and directly manages the production, harvest, storage, and transportation of feedstocks (Epplin et al. 2007). Another alternative for the processing plant is to enter into long-term production and harvest contracts with individual farmers (Epplin et al., 2007). There may also be opportunities for farmer cooperative-based vertical ownership of the bioenergy processing plant for the local market. This research evaluates the potential impact on farm-level risk and return of several potential biomass contract structures that could be used long-term production and harvest contracts with individual farmers.

A number of factors may influence farmers' willingness to supply biomass feedstocks such as corn stover, wheat straw, and/or switchgrass to a local processing facility. For example, how do biomass crops such as switchgrass compare to traditional crops with respect to costs of production, yields, price potential in terms of its energy equivalent to gasoline or coal, net returns, and risk (variability of net revenues) under different management practices, weather conditions, energy market conditions, government policies, and contract pricing arrangements provided by the processing plant? Supplying biomass feedstocks will require changes in the way farmers manage their operations.

The ability of farmers to respond to a potential market for biomass feedstocks will be constrained by on-farm economic, structural, and resource constraints (e.g., time constraints, equipment constraints, land ownership, debt structure, farm size, production activities (i.e., crop, livestock), soil type and topography, farm program participation, etc.). For example, who would pay for investment in perennial crop establishment, harvest equipment, and storage for the biomass? Would the farm have enough labor resources to grow and harvest the crop? Farmers who must bear all of the feedstock price, production risks, and financial risks may not be willing to supply biomass or be willing to supply limited amounts of biomass at all to a processing facility. The willingness of farmers to provide biomass feedstocks will be a function of biomass feedstock profits, variability of profits, and correlation of profits relative to traditional crop profits. These factors will vary with respect to the contractual incentives that may be offered by the processing facility. Thus, an understanding of the factors that will affect farmer decisions to supply biomass feedstocks is essential.

Currently, research about the potential risks and risk management benefits of on-farm biomass production is lacking. In addition, analysis of the impacts of potential biomass contract structures on risk and return and farmer willingness to supply biomass is also limited. Larson et al. (2005) evaluated the risk management benefits of a marketing contract with a penalty for production underage or excess production is sold at the spot market price based on the energy equivalent value as a substitute for gasoline on farmer willingness to supply switchgrass, corn stover, or wheat straw. However, the Larson et al (2005) study did not evaluate other potential contract alternatives such as acreage contracts (Paulson and Babcock, 2007), gross revenue contracts (Garland, 2007), or other financial incentives that could be used to induce on-farm biomass production for a processor. Thus, the objective of this research is to evaluate the risk and return tradeoffs of producing biomass feedstocks under alternative contractual arrangements with a processing facility. The analysis was conducted for representative grain farm located in northwest Tennessee.

Methods and Data

Representative Farm

A farm-level model was developed to evaluate contract biomass feedstock production under risk for a northwest Tennessee 2,400 acre grain farm. The farm was assumed to produce corn, soybeans, and winter wheat. The representative farm also was assumed to have the opportunity to provide biomass feedstocks to a local single-user facility that produces ethanol. The farm was assumed to be able to produce three energy crop production alternatives: corn stover, wheat straw and switchgrass. Thus, the representative farm had the choice between producing corn grain only or corn grain and corn stover. Similarly, the representative farm could produce wheat grain only or wheat grain and wheat straw for sale to individual, wholesalers, and retailers or wheat straw for ethanol production.

Risk Programming Model

A quadratic programming model incorporating farm labor and land quality constraints, biomass yield variability, crop and energy price variability, alternative contractual arrangements, and risk aversion was developed for the analysis. The objective function was to maximize the certainty equivalent value of whole farm net revenues for different levels of risk significance (McCarl and Bessler, 1989). Risk significance levels (α) of 50, 60, 70, 80, and 90 percent were used to generate risk-efficient farm plans for different levels of absolute risk aversion. The risk levels model the certainty of obtaining or exceeding a maximized lower level confidence limit on net revenues (Dillon, 1999). Thus, for a risk neutral decision maker a 50% percent certainty that the actual net revenues will meet or exceed expected net revenues. For risk averse decision makers, a higher probability of certainty is required on net revenues; thus, a risk significance levels (α) of higher than 50% is required.

The three resource constraints specified in the model were for soil type, labor, and available field days for wheat straw and corn stover harvest. Total land was restricted to 2,400 acres and land for each soil type was restricted to 1,200 acres of Collins soils, 528 acres of Loring soils, and 672 acres of Memphis soils. Six bimonthly labor periods were specified in the model. Labor requirements by period were from crop budgets by Gerloff (2007a; 2007b). Labor availability by period was for a family of four (Johnson, 1991). In addition to family labor, it was assumed that the farm could hire an additional 2,000 hours of labor per year at $8.50/hour (Gerloff, 2007a). Hired labor was assumed to have an efficiency of 90% in the model to account for the extra management time for the farm operator (Musser, Mapp, and Barry, 1984). The number of suitable days available to harvest corn stover and wheat straw after grain harvest was constrained to 21-10 hour days. For the soybean-wheat double crop, the available days to harvest straw between the wheat grain harvest and the planting of the soybean crop was assumed to be 10-10 hour days.

Biomass Contracting Alternatives

The potential biomass contracting alternatives modeled for the west Tennessee representative crop farm were: 1) a spot market contract (SPOT) where biomass is priced yearly on its current energy equivalent value as a substitute for gasoline at the processing plant gate, 2) a standard marketing contract (STANDARD) with a penalty for production underage or excess production is sold at the spot market price (Musser, Mapp, and Barry, 1984; Paulson and Babcock, 2007), 3) an acreage contract (ACREAGE) which provides a guaranteed annual price on the actual biomass produced in each year on the contracted biomass acreage (Paulson and Babcock, 2007), and 4) a gross revenue contract (REVENUE) which provides a guaranteed annual gross revenue per acre from biomass based on a guaranteed contract price times expected yield per acre over the life of the contract (Garland, 2007).

The four potential types of contracts that could be used to encourage biomass production offer different levels of biomass price, yield, and production cost risk sharing between the representative farm and the processor. The SPOT contract assumes that all of the output price, yield, and production cost risk from biomass production is borne by the farmer. With the STANDARD contract, a portion of the price risk on expected production is shifted from the producer to the processor. All of the price risk is shifted from the farmer to the processor with an ACRAGE contract but the farmer still incurs all yield and production cost risk. On the other hand, the gross revenue contract provides the greatest potential risk benefits to the farmer because all of the biomass price and yield risk is assumed by the processor. In addition, a contract provision for switchgrass that provides a financial incentive to reduce production cost risk by covering the materials cost of establishing the switch grass stand was also modeled. The gross revenue contract and the planting incentive are two potential switchgrass production incentives that are being consider for contract production for the cellulosic ethanol pilot plant being constructed for Tennessee Biofuels Initiative (Garland, 2007). The time period for each of the four types of contracts modeled was assumed to be 5 years (Garland, 2007).

Simulation Analysis

A 99 year distribution of net revenues for each the crop activity was simulated for use in the quadratic programming model to determine risk-efficient farm plans under the alternative contracting scenarios. The variables treated as random in the simulation of net revenues were crop prices, crop yields, nitrogen fertilizer price, diesel fuel price, and selected biomass harvest and transportation costs as a function of harvested yield. The ALMANAC crop model (Kiniry et al., 2005) was used to simulate random crop yields for the continuous crop and crop rotations on the Loring, Memphis, and Collins soils for the representative farm. A 99 year set of real, detrended, and correlated prices for corn, soybeans, wheat, wheat straw, corn stover, switch grass, nitrogen fertilizer, and diesel fuel were simulated using the @Risk simulation model in Decision Tools (Palisade Corporation, 2007). Energy equivalent price series for switchgrass, corn stover, and wheat straw as an ethanol based energy substitute for gasoline were constructed using wholesale gasoline price data for 1977 through 2004 (U.S. DOE, 2007) and biomass conversion to ethanol factors from Wang, Saricks, and Santini (1999). The number of gallons of ethanol assumed to be produced per dry ton (dt) of biomass was assumed to be 69.2 gallons for wheat straw, 72 gallons for corn stover, and 76 gallons for switchgrass. Contract prices for corn stover and wheat straw were adjusted downward by 5 percent and 9 percent, respectively, from the contract price for switchgrass to reflect the lower gallons per dt produced.

Corn, soybean, wheat, and soybean-wheat production costs were derived from University of Tennessee Extension budgets (Gerloff, 2007a). All three biomass crops were assumed to be harvested using a large round bale system with the bales being moved to the edge of the field before transport to the user facility. Switchgrass production costs were estimated using a budget produced by University of Tennessee Extension (Gerloff, 2007b).

Results and Discussion

Base Scenario Risk Efficient Farm Plans Without Biomass Crops

The profit-maximizing farm plan that does not consider biomass crop production alternatives is presented in Table 1. The profit maximizing farm plan in the absence of biomass crop alternatives produced 528 acres of continuous corn on the Loring soil and 1,200 acres of continuous corn on the Loring soil. A combination of 100 acres of continuous corn, 420 acres of wheat grain and straw, and 152 acres of soybean-wheat, double-crop grain and straw were produced on the Memphis soil. Because of its relative profitability, the farm produced the maximum amount of straw for sale to wholesalers/retailers given the constraint on available harvest time. Mean farm net revenue for the base profit maximizing farm plan was $472,175 with a standard deviation of net revenues of $152,926. In general, mean crop net revenues were the largest on the Memphis soil and the smallest on the Collins soil. The coefficient of variation of crop net revenues, a measure of relative risk (variation) of net revenues, was generally higher (riskier) for crop enterprises on the poorer quality Collins soil and lower (less risky) on the higher quality Memphis and Collins soils.

Risk significance levels of 50, 60, 70, 80, and 90 percent were used to generate risk-efficient farm plans for different levels of absolute risk aversion. Parameterization of the programming model to include absolute risk aversion did not change the risk efficient crop mix from the base profit maximizing solution for the 50, 60, 70, and 80 percent risk significance levels. For these levels of risk significance, no other combination of crop enterprises on the three soil types provided a more favorable risk-return tradeoff. In these cases, the most profitable crop enterprise was also the least risky. For the 90 percent risk significance level the crop mix became more diversified on the Memphis and Loring soils. Crops produced on the Loring soil were 274 acres of continuous corn, 134 acres of soybeans, 112 acres of continuous winter wheat grain and straw, and 152 acres of soybean-wheat, double-crop grain and straw. For the Loring soil, the optimal crop mix changed from all continuous corn to a combination of 913 acres of continuous corn and 287 acres of continuous wheat grain and straw.

Risk Efficient Farm Plans With Biomass Crops

The important findings under the biomass production scenario were as follows. First, under the SPOT scenario, biomass prices averaged $29.44/dt (standard deviation of $9.34/dt) for wheat straw, $29.44/dt (standard deviation of $15.50/dt) for corn stover, and $34.77/dt (standard deviation of $7.43/dt) for switchgrass. When biomass crops were priced annually based on the energy equivalent price, the production of biomass crops did not enter into the optimal crop mix for any risk significance level except the most risk averse 90 percent level (Table 2). For this level of risk aversion, only 36 acres on switchgrass was planted on the poorest quality Collins soil. No other biomass crops were planted on the rest of the farm. Thus, an average of only 324 dt of biomass would be supplied by the representative farm under the SPOT contract scenario. In general, the net revenues from biomass crops were not high enough under SPOT contract prices to induce biomass production Results indicate that a contract price above the energy equivalent price would be needed to encourage biomass production on the representative farm.

Second, the ACREAGE and REVENUE contracts were more effective at inducing maximum farm biomass production at lower contract prices than the STANDARD contract for a risk neutral decision maker (Figure 1). Under the assumption of risk neutrality, the same amount of biomass was supplied by the representative farm under the REVENUE contract as under the ACREAGE contract. Expected biomass crop net revenues were identical for both contract structures. Most of the biomass supplied by the representative farm under the STANDARD, ACREAGE, and REVENUE contracts was from switchgrass. In addition, some corn stover was produced but no wheat straw was supplied for ethanol production by the representative farm.

Third, because the REVENUE contract reduced biomass crop net revenue variability relative to the ACREAGE contract, the REVENUE contract provided more risk benefits to the representative farm under the assumption of risk aversion (Figure 2). In addition, because of the greater price and yield protection offered with the REVENUE contract, swtichgrass production was generally induced at lower contract prices than with the STANDARD contract. Fourth, results of this study suggest that a planting incentive to offset part of the cost of establishing switchgrass may be effective at inducing biomass larger production at lower contract prices. The incentive may provide a method for the processor to reduce average per ton cost of material at the plant gate for perennial biomass crops such as switchgrass.

Finally, as more of the farm crop area was planted into biomass crop at higher contract prices, the greater the annual variation in biomass supplied to the processing plant (Figure 3). Thus, for a processor, there may be a relationship between the annual variation in biomass material supplied and the cost of biomass materials. A higher contract price may induce more production on an individual farm. This could result in fewer farms in a more concentrated geographic area being needed to supply the plant. The biomass materials transportation cost may be lower but the biomass storage cost incurred to ensure a steady supply of feedstock to the plant may be higher with the increased variability of annual biomass production with higher contract prices.

Conclusions

This study developed a farm-level model to evaluate the ability and willingness of farmers to provide biomass feedstocks for a northwest Tennessee 2,400 acre grain farm under alternative contract arrangements. A quadratic programming model incorporating farm labor and land quality constraints, biomass yield variability, crop and energy price variability, alternative contractual arrangements, and risk aversion was developed for the analysis. The four potential types of contracts analyzed in this study that could be used to encourage biomass production offer different levels of biomass price, yield, and production cost risk sharing between the representative farm and the processor. The spot market contract (SPOT) based on the yearly energy equivalent value with gasoline assumes that all of the output price, yield, and production cost risk from biomass production is incurred by the farmer. With the standard marketing contract (STANDARD), a portion of the price risk on expected production is shifted from the producer to the processor. All of the price risk is shifted from the farmer to the processor with an acreage contract (ACREAGE) that pays a specified price for all production produced on the contracted acreage. However, the ACREAGE contract does not provide any protection against yield risk and production cost risk. On the other hand, the gross revenue contract (REVENUE) provides the greatest potential risk benefits to the farmer because all of the biomass price and yield risk is assumed by the processor. In addition, a contract provision for switchgrass that provides a financial incentive to reduce production cost risk by covering the materials cost of establishing the switch grass stand was also modeled.

The important findings from this research were as follows. First, under the spot market price contract scenario, the net revenues from biomass crops were not high enough induce biomass production on the representative farm Results indicate that a price above the energy equivalent price would be needed to encourage biomass production on the representative farm. Biomass prices under the SPOT contract scenario averaged $29.44/dt (standard deviation of $9.34/dt) for wheat straw, $29.44/dt (standard deviation of $15.50/dt) for corn stover, and $34.77/dt (standard deviation of $7.43/dt) for switchgrass.

Second, the ACREAGE and REVENUE contracts were more effective at inducing maximum farm biomass production at lower contract prices than the STANDARD contract for a risk neutral decision maker. Under the assumption of risk neutrality, the same amount of biomass was supplied by the representative farm under the REVENUE contract as under the ACREAGE contract. Expected biomass crop net revenues were identical for both contract structures. Most of the biomass supplied by the representative farm under the STANDARD, ACREAGE, and REVENUE contracts was from switchgrass. In addition, some corn stover was produced but no wheat straw was supplied for ethanol production by the representative farm.

Third, because the REVENUE contract reduced biomass crop net revenue variability relative to the ACREAGE contract, the REVENUE contract provided more risk benefits to the representative farm under the assumption of risk aversion. In addition, because of the greater price and yield protection offered with the REVENUE contract, swtichgrass production was generally induced at lower contract prices than with the STANDARD contract. Fourth, results of this study suggest that a planting incentive to offset part of the cost of establishing switchgrass may be effective at inducing biomass larger production at lower contract prices. The incentive may provide a method for the processor to reduce average per ton cost of material at the plant gate for perennial biomass crops such as switchgrass.

Finally, as more of the farm crop area was planted into biomass crop at higher contract prices, the greater the annual variation in biomass supplied to the processing plant. Thus, for a processor, there may be a relationship between the annual variation in biomass material supplied and the cost of biomass materials. A higher contract price may induce more production on an individual farm. This could result in fewer farms in a more concentrated geographic area being needed to supply the plant. The biomass materials transportation cost may be lower but the biomass storage cost incurred to ensure a steady supply of feedstock to the plant may be higher with the increased variability of annual biomass production with higher contract prices.

References

Dillon, C.R. 1999. Production practice alternatives for income and suitable field day risk management. *Journal of Agricultural and Applied Economics* 31: 247-261.

English, B.C., D.G. De La Torre Ugarte, K. Jensen, C. Helllwinckel, J. Menard, B. Wilson, R. Roberts, and M. Walsh. 2006. 25% Renewable Energy for the United States by 2025: Agricultural and Economic Impacts. Department of Agricultural Economics Staff Paper. Knoxville, TN: The University of Tennessee, Institute of Agriculture, November 2006. Available online at: http://beag.ag.utk.edu/

Epplin, F.M., C.D. Clark, R.K. Roberts, and S. Hwang. 2007. "Challenges to the Development of a Dedicated Energy Crop." *American Journal of Agricultural Economics* 89: 1296-1302.

Garland, C.D., Professor of Agricultural Economics and Extension Specialist. 2007. Personal communication, September 2007.

Gerloff, D. Field crop budgets. 2007a. AE 07-32. University of Tennessee Extension, Knoxville, TN

Gerloff, D. Switchgrass working budgets. 2007b. AE 07-43. University of Tennessee Extension, Knoxville, TN

Johnson, L.A., 1991. Guide to farm planning. University of Tennessee Agricultural Extension Service, Knoxville, TN. EC622.

Kiniry, J.R., J.R. Williams, P.W. Gassman and P. Debaeke. 1992. A general, process-oriented model for two competing plant species. *Transactions of the ASAE* 35: 801–810.

Larson, J.A., B.C. English, C. Hellwinckel, D. De La Torre, Ugarte and M. Walsh. 2005. A farm-level evaluation of conditions under which farmers will supply biomass feedstocks for energy production. Selected Paper at the 2005 American Agricultural Economics Association Annual Meeting, 24-27 Jul. 2005, Providence, RI.

McCarl, B.A.,and D. Bessler. 1988. Estimating the upper bound on the Pratt Risk aversion coefficient when the utility function is unknown. *Australian Journal of agricultural Economics* 33: 56-63.

Musser, W.N., H.P. Mapp, Jr., and P.J. Barry. 1984. Chapter 10: Applications I: Risk programming, pp.129-147. In (P.J. Barry), *Risk Management in Agriculture*. Iowa State University Press, Ames, IA.

Palisade Corporation. 2007. Decision Tools Suite. Palisade Corporation, Ithaca, New York.

Paulson, N.D., and B.A. Babcock. 2007. The Effects of Uncertainty and Contract Structure in Specialty Grain Markets. Selected paper presented at the American Agricultural Economics Association Annual Meeting, Portland Oregon, July 29-August 1, 2007. On-line at AgEcon Search: http://ageconsearch.umn.edu.

Perlack, R.D., L.L. Wright, A.F. Turhollow, R.L. Graham, B.J. stokes, and D.C. Erbach. 2005. "Biomass as afeedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply." Washington DC: U.S. Department of Agriculture, U.S. Department of Energy.

U.S. Department of Energy. 2007. Table 1. Energy Price and Expenditure Estimates by Source, 1970-2001, Tennessee. Washington, DC: Energy Information Administration, DOE, January. Online at: http://www.eia.doe.gov/emeu/states/ ep_prices/total/footnotes.

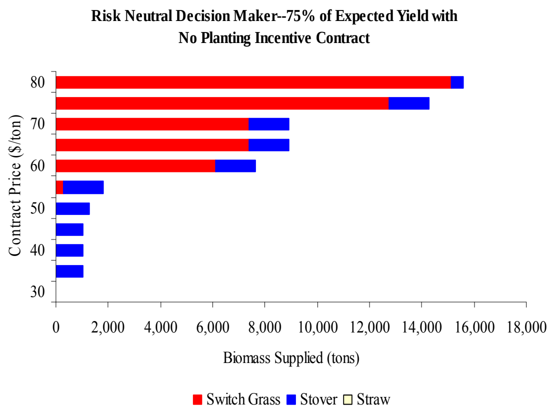
Wang, M., C. Saricks, and D. Santini, 1999. Effects of fuel use on fuel-cycle energy and greenhouse emissions. Center for Transportation Research, Energy Systems Division, Argonne National Laboratory, Argonne, IL. ANL/ESD-38.

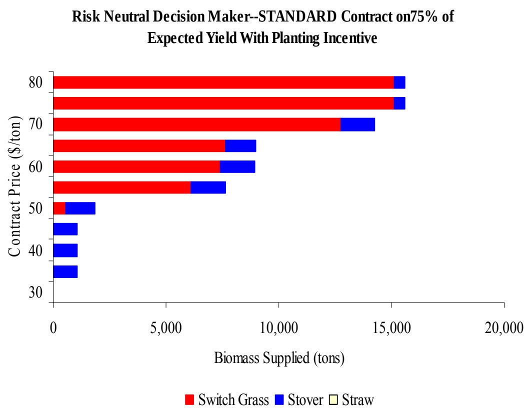
Table 1. Risk Efficient Net Revenues, Crop Area, and Labor Usage without Biomass Crop Enterprises (Base Scenario)

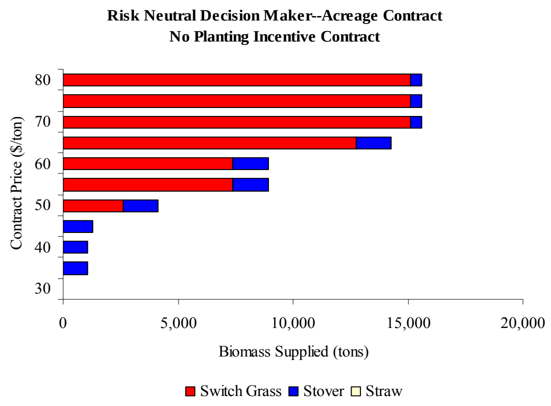
	Risk Significance Level (Percent)				
Item	50	60	70	80	90
Whole-Farm Net Revenue	--------------------------------	------------------------------$	--------------------------------		
Mean	472,175	472,175	472,175	472,175	472,440
Standard Deviation	152,926	152,926	152,926	152,926	141,091
Certainty Equivalent	472,175	437,096	390,323	343,550	277,878
Collins Soils Crops	------------------------------	Acres	------------------------------		
Corn	528	528	528	528	528
Memphis Soils Crops	------------------------------	Acres	------------------------------		
Corn	100	100	100	100	274
Soybean	0	0	0	0	134
Wheat grain & straw	420	420	420	420	112
Soybean-wheat grain & straw	152	152	152	152	152
Loring Soils Crops	------------------------------	Acres	------------------------------		
Corn	1,200	1,200	1,200	1,200	913
Wheat grain & straw	0	0	0	0	287
Labor Use	------------------------------	Hours	------------------------------		
Jan-Feb	13	13	13	13	13
Mar-Apr	50	50	50	50	74
May Jun	1,375	1,375	1,375	1,375	1,344
Jul-Aug	2	2	2	2	2
Sep-Oct	679	679	679	679	682
Nov-Dec	80	80	80	80	77
Total	2,199	2,199	2,199	2,199	2,192
Hired Labor	------------------------------	Hours	------------------------------		
May-June	778	778	778	778	743
Sep-Oct	105	105	105	105	107
Total	883	883	883	883	851

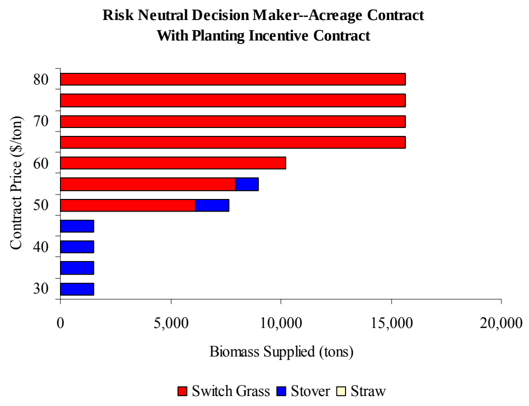
Table 2. Risk Efficient Net Revenues, Crop Area, and Labor Usage Assuming Spot Market Biomass Contract Pricing with the User Facility

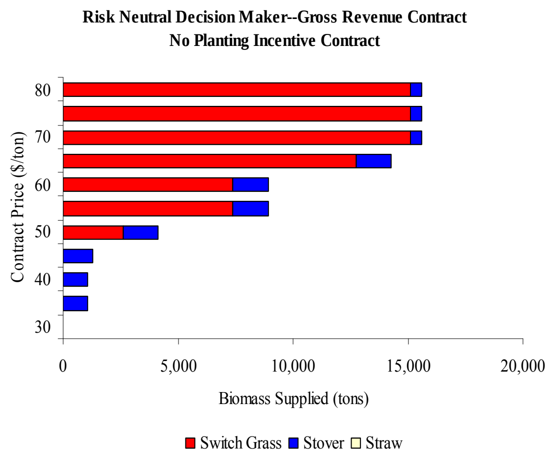
	Risk Significance Level (Percent)				
Item	50	60	70	80	90
Whole-Farm Net Revenue	--------------------------------$--------------------------------				
Mean	472,175	472,175	472,175	472,175	449,666
Standard Deviation	152,926	152,926	152,926	152,926	139,154
Certaint Equivelant	472,175	437,096	390,323	343,550	277,987
Collins Soils Crops	-----------------------------Acres-----------------------------				
Corn	528	528	528	528	492
Switchgrass	0	0	0	0	36
Memphis Soils Crops	-----------------------------Acres-----------------------------				
Corn	100	100	100	100	282
Soybean	0	0	0	0	125
Wheat grain & straw	420	420	420	420	113
Soybean-wheat grain & straw	152	152	152	152	152
Loring Soils Crops	-----------------------------Acres-----------------------------				
Corn	1,200	1,200	1,200	1,200	917
Wheat grain & straw	0	0	0	0	283
Labor Use	-----------------------------Hours-----------------------------				
Jan-Feb	13	13	13	13	13
Mar-Apr	50	50	50	50	72
May Jun	1,375	1,375	1,375	1,375	1,340
Jul-Aug	2	2	2	2	2
Sep-Oct	679	679	679	679	671
Nov-Dec	80	80	80	80	130
Total	2,199	2,199	2,199	2,199	2,227
Hired Labor	-----------------------------Hours-----------------------------				
May-June	778	778	778	778	739
Sep-Oct	105	105	105	105	95
Total	883	883	883	883	834











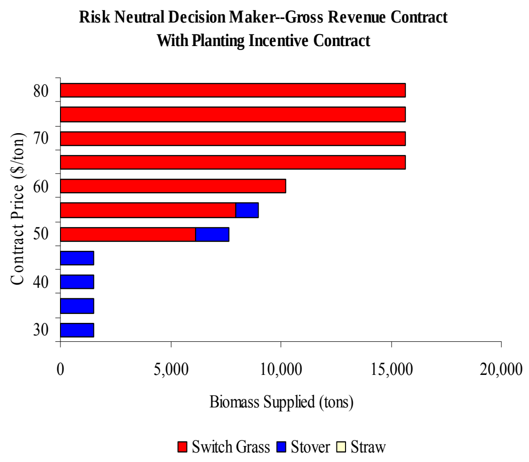


Figure 1. Representative Farm Biomass Supplied at Different Contract Prices for the STANDARD, ACREAGE, and REVENUE Contract Scenarios Assuming a Risk Neutral Decision Maker

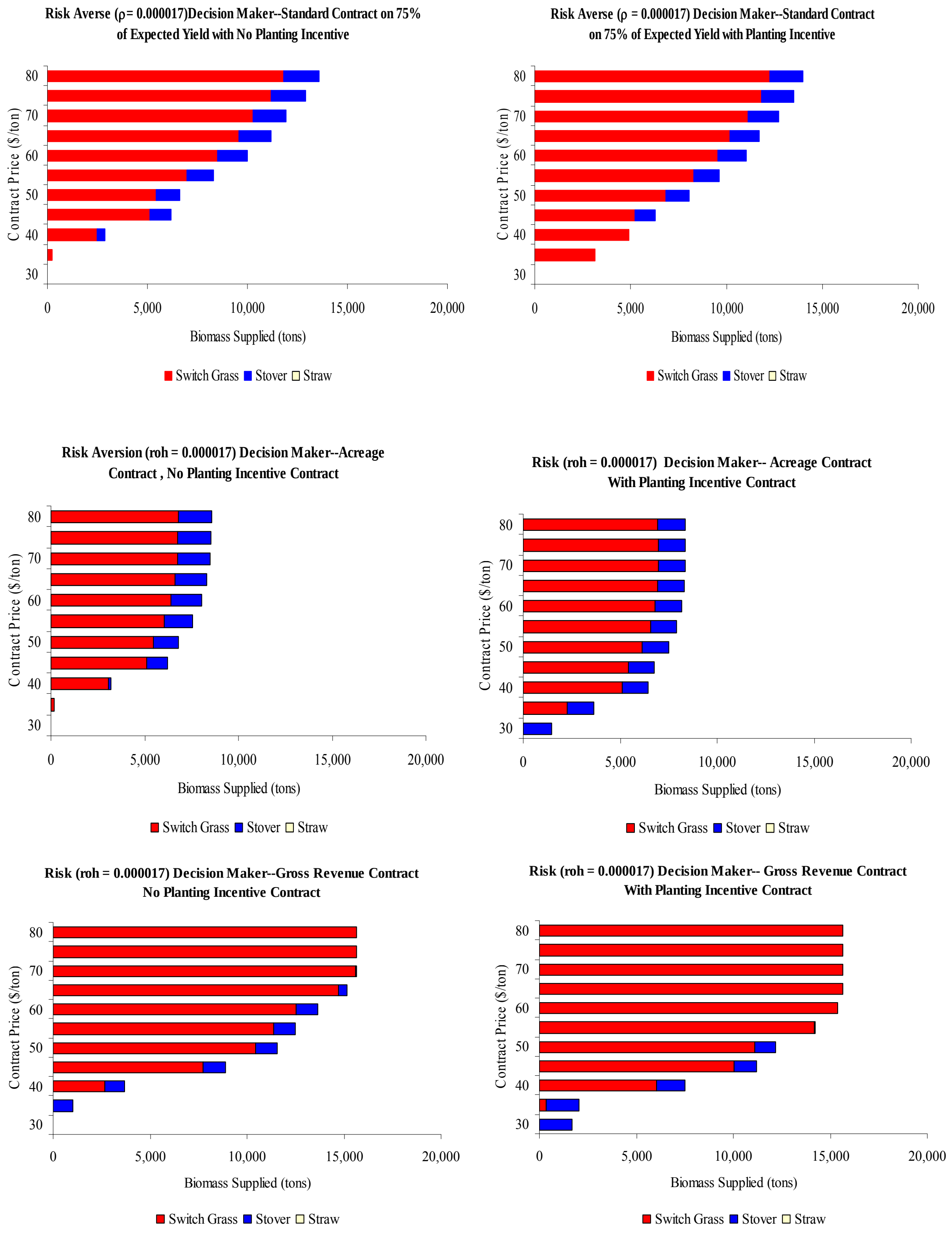


Figure 2. Representative Farm Biomass Supplied at Different Contract Prices for the STANDARD, ACREAGE, and REVENUE Contract Scenarios Assuming a Risk Averse Decision Maker (90 percent Risk Significance Level)

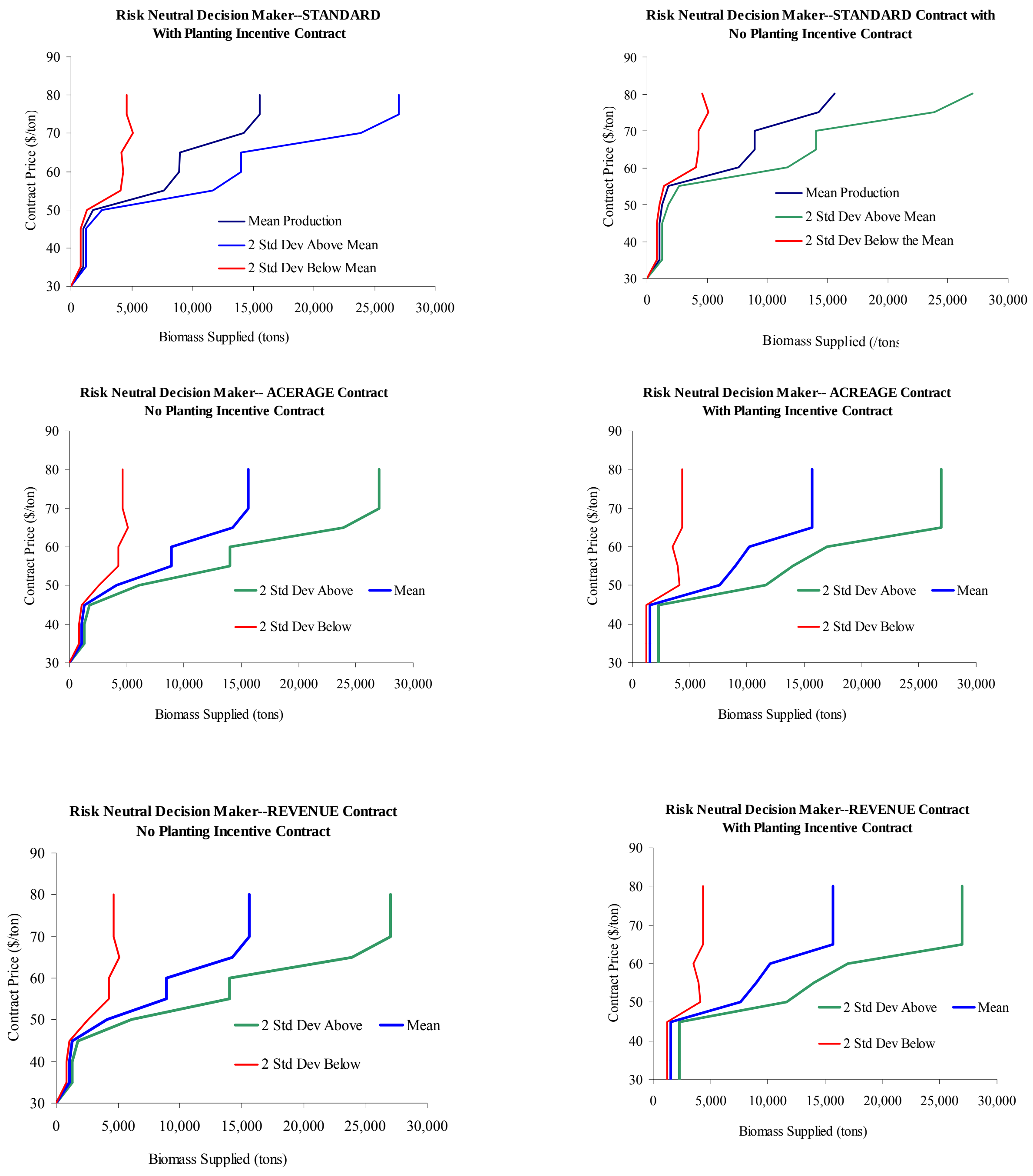


Figure 3. Representative Farm Biomass Supplied at Different Contract Prices for the STANDARD, ACREAGE, and REVENUE Contract Scenarios Assuming a Risk Neutral Decision Maker