CONVENTIONAL VS. TRANSGENIC: THE SHOWDOWN

Rob Hogan
Texas A&M Extension Center
Fort Stockton, TX
Jason L. Johnson
Texas A&M Research and Extension Center
Stephenville, TX
Warren L. Multer
Texas AgriLife Extension
Garden City, TX
M. Wade Polk
Texas A&M Research and Extension Center
San Angelo, TX

Abstract

A profitability analysis of two production alternatives: 1) GMO or transgenic and 2) conventional non-GMO or brownbag cotton was conducted for dryland cotton in West Texas. Production budgets for both cultivars were constructed. From these budgets, a mathematical model was created to compute net profit or loss from both alternatives that includes government program payments, crop insurance, stochastic prices and yields, and weather anomalies. Using the model stochastic simulation was performed on the two cultivar alternatives to compute net profit or loss both after direct out-of-the-pocket costs were deducted and after total specified costs including a cash rent cost for land were deducted from estimated total revenue. These net revenue values for 500 iterative production periods were graphed as four cumulative distribution functions (CDFs). From this graph, it is obvious the brownbag alternative is the preferred solution over the transgenic alternative. In addition, stochastic dominance analysis showed the brownbag cultivar alternative was the preferred solution set under both first and second-degree stochastic dominance. Finally, confidence premiums show that net revenue, after direct costs, were improved by $9.83 per acre under the brown bag alternative as compared to the B2RRF transgenic alternative and net revenue after total specified costs, were enhanced by $6.77 per acre using the brownbag alternative.

Introduction

The development of transgenic cotton cultivars gave cotton producers more risk management options for insect control and weed suppression. The insect and weed suppression characteristics of transgenic cotton provide the potential to greatly reduce a common source of production risk for all cotton producers. As production risk is reduced, yield and production costs become less variable and net returns become more predictable and estimable. Studies showing a higher probability of positive net revenues were conducted in Arkansas (Bryant et al., 2002) and Mississippi (Cooke et al., 2001). At the same time producers were learning to enjoy all the benefits of transgenic cotton, seed vendors began to change their product pricing structure in order to profit from this reduced risk. These vendors began to charge technology fees for some portion of the enhanced profit potential brought about by this new genetically customized germplasm. With the built in Bacillus thuringiensis (Bt) gene, which expresses one or more endotoxins, produced by the soil bacterium, cotton would now be able to defend itself from depredations from pests. Expression of the toxins suppresses feeding by armyworm species (Spodoptera spp.) and is from moderately to highly effective for control of tobacco budworm [Heliothis virescens (F.)] and cotton bollworm [Helicoverpa zea (Boddie)], respectively. However, the Bt endotoxins do not control other major insect pests of cotton, such as the boll weevil (Anthonomus grandis Boheman). In addition, weed control became much more straightforward and less expensive as Roundup® could be applied over the top of the growing cotton plants to kill weedy pests.

However, as time has passed and production costs of cotton have increased relative to cotton revenues. Net revenues have decreased even as technology fees have increased thus forcing producers to consider the prospect of changing their production methods back to non-transgenic cultivars. The objective of this research is to determine if it is still economically feasible to use the transgenic production system for dryland cotton production in West Texas.

Methods

Production budgets for both a generic transgenic Bollguard II Roundup Ready Flex (B2RRF) cultivar and a conventional cotton cultivar, i.e. not genetically modified cotton or brown bag cotton were constructed. An interactive focus group was then formed to modify and amend these model budgets so they represented the actual cultural practices used by dryland cotton producers in Texas.

These model budgets then became the foundation of a mathematical model, which describes both the physical and economic production process for dryland cotton. Once the model was constructed, the generating functions for the simulation process could be defined. A 21-year data series for Texas cotton yields and prices was obtained for the years 1988 through 2008 (U.S. Department of Agriculture, 2010). After testing to determine which distribution most closely fit the data series it was determined that the best fit was obtained with a multivariate empirical distribution. Both stochastic price and yield generating functions were developed and tested against the mean and standard deviation of the data series to validate their accuracy.

It was further determined from the years of yield data studied that approximately one year out of three resulted in a weather event which reduced the normal yield by some 75% for that production period. A stochastic generating function was developed to simulate this variable that was random and uniform.

An econometric model was then developed to describe the dryland cotton production process. This model computed net revenue after direct and total specified costs were deducted from gross revenue. The model considered crop insurance, program payments (direct and countercyclical payments), and deduction for cash cropland rent. The simulation engine then iterated the model through 500 production periods using the Latin Hypercube algorithm.

Results

The model was based upon the following assumptions for both production alternatives:

- There is an anomalous weather event every third year.
- A weather event is accompanied by a yield loss of 75%.
- The average yield of the B2RRF cultivar was 453 lbs. of lint per acre.
- Average yield of the brown bag cultivar is 10 lbs. per acre per year less than the B2RRF cultivar.
- Market price does not fall below the 52¢ per lb. loan price. There is a $150.00 per acre revenue guarantee from crop insurance.
- The APH and FSA yield used to compute both direct payment (DP) and countercyclical payment (CCP) are equal and are 375 lbs. lint per acre per year.
- The annual B2RRF direct (variable) cost = $213.68 per acre, the annual fixed cost = $10.17 per acre, and the land cash rent charge = $15.00 per acre.
- The brownbag annual direct cost = $202.59, annual fixed cost = $13.23, and the land cash rent charge = $15.00 per acre.
- The B2RRF and brownbag production budgets apply equally well to every producer in the Glasscock, Reagan, and Upton County area in West Texas.
- The program payments for cotton are the same each production period, direct payment = $14.67 per acre and the countercyclical payment = $27.67 per acre.
- There were 500 simulated total production periods.

The simulation used a Latin Hypercube rather than a Monte Carlo procedure to sample the probability distributions. The number of iterations a model must simulate can be greatly reduced if the simulations are executed with Latin Hypercube. The Monte Carlo procedure randomly selects values from the probability distributions. As a result the procedure samples a greater percent of the random values from the area about the mean and under samples the area under the tails. An alternative technique for sampling probability distributions is the Latin Hypercube sampling procedure (Inman, Davenport, and Zeigler, 1980). This technique segments the distribution into N intervals and makes sure that at least one value is randomly selected from each interval. By sampling from each of these N intervals, the Latin Hypercube insures that all areas of the probability are considered in the simulation. The Simetar© Simulation Add-in for Excel was used as the simulation engine and for extended statistical functions in this study.

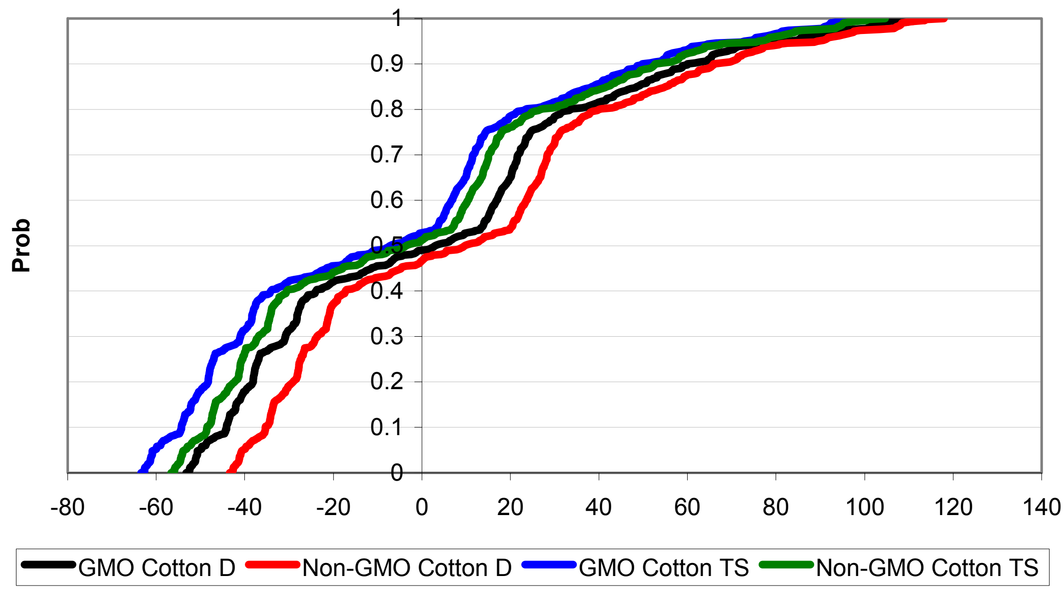

Figure 1. Comparison of the four net revenue streams with cumulative density functions.

Net profit and loss were calculated for each production period with revenue provided from the sale of cotton lint and cotton seed. All profits and losses for the short-term outcome where only direct costs were covered in the B2RRF and brownbag regimes were graphed. Then the long-term outcome data where total specified costs were covered was graphed for the B2RRF and brownbag data. These are all graphed on Figure 1 versus their associated probabilities of losing money.

The data series that appears to the right of its mate is the preferred (more profitable) alternative. For example, look at the short-term outcome pair B2RRF direct (black line) and brownbag direct (red line). The red line lays to the right of the black line in all cases, so the brownbag alternative is preferred over the B2RRF alternative. Stochastic dominance analysis for the two production alternative scenarios showed that the brownbag alternative was the dominant solution under both first and second-degree stochastic dominance in both the short and long terms. In other words, if we are only concerned about covering our direct out-of-the-pocket costs we are better off using the brownbag production alternative even though it is more risky. So, for a producer to be economically indifferent between the two alternatives, a producer planting B2RRF would have to be paid \$9.83 per acre if that producer was risk averse.

However, our producer cannot farm long if only direct costs are covered, so in the long-term—total specified (direct and fixed) costs must be covered—the brownbag total cost (green line) lays to the right of the B2RRF total cost (blue line). The brownbag production alternative is favored over the transgenic alternative in the long-term instance also. The risk averse B2RRF producer must be paid \$6.77 per acre to be indifferent between the two alternatives.

Conclusions

Using stochastic simulation to model scenarios of the two production alternatives of the cotton cultivars B2RRF (GMO) and brownbag (non-GMO) using both stochastic dominance analysis and confidence premiums between the probability distributions show the brownbag alternative is the more preferred. In other words, cotton production using conventional or brownbag cultivars is more economically feasible for West Texas dryland cotton producers than transgenic cultivars. It should be noted that this simulation is region specific and may not adequately measure the benefits of transgenic seed varieties in higher yielding cotton production regions. For this region, this analysis indicates that the fees or production costs associated with this seed technology may be priced too high. That does not mean that similar technology fees or production costs in other regions are not economically feasible. Similarly, the value of technology adoption, which results in any yield increase, will obviously be influenced by the price of cotton. This simulation used historical price data, which might underestimate the current benefits that result in the current environment of relatively high cotton prices.

Acknowledgment

This research paper is a summary of a research project supported and funded by Cotton Incorporated.

References

Bryant, Kelly J., William C. Robertson, Gus M. Lorenz, Rob Ihrig, George Hackman. 2002. Six years of transgenic cotton in Arkansas. In Proc. Beltwide Cotton Conf., Atlanta, GA. 9-12 Jan. 2002. Natl. Cotton Counc. Am., Memphis, TN.

Cooke, Fred T. Jr., William P. Scott, Steven W. Martin, and David W. Parvin. 2001. The economics of Bt cotton in the Mississippi delta: 1997-2000. p. 175-177. In Proc. Beltwide Cotton Conf., Anaheim, CA. 9-13 Jan. 2001. Natl. Cotton Counc. Am., Memphis, TN.

Inman, R.L., J.M. Davenport, and D.K. Zeigler. "Latin Hypercube Sampling (a Program User's Guide)." Technical Report SAND 79-1473 Sandia Laboratories, Albuquerque, NM, 1980.

U.S. Department of Agriculture. 2010. National Agricultural Statistics Service. *All States Data – Crops Planted, Harvested, Yield, Production, Price(MYA), Value of Production, 1988—2008*. Washington DC. Online at: http://www.nass.usda.gov/QuickStats/PullData_US.jsp.