2007 Beltwide Cotton Conferences, New Orleans, Louisiana, January 9-12, 2007

SYSTEMS ENGINEERING OF SEED COTTON HANDLING AND GINNING IN TEXAS

Scott Emsoff
Texas A&M University - BAEN/CAAQES
College Station, TX
Calvin B. Parnell
Department of Biological and Agricultural Engineering
College Station, TX
Shay L. Simpson
Mark Hamann
Texas A&M University
College Station, TX
Bryan W. Shaw
Center for Agricultural Air Quality Engineering and Science
College Station, TX
Sergio Capareda
Texas A&M University
College Station, TX

Abstract

The number of cotton gins in the state of Texas has declined from over 1400 gins in 1960 to less than 280 gins in 2006. Production in the state of Texas has remained relatively constant at 5 million bales except for the 2004/05 and the 2005/06 ginning seasons in which production was boosted to over 7 million bales. Two immediate problems come from the decline in the number of gins and the constant or increased annual production: (1) Remaining gins must gin more seed cotton creating longer ginning seasons; and (2) Seed cotton must be shipped greater distances in order to be ginned with corresponding increases in seed cotton transportation costs. Gin cost surveys from approximately 200 gins and multi-year economic data from over 10 cooperating gins in Texas have provided the base data for the development of decision support software. Preliminary results suggest that the optimum percent utilization for least cost (variable and fixed cost per bale) ginning increases with the ginning rate. It has been hypothesized that this optimum point in the cost-per-bale versus %U relationship will vary for gins processing stripper and picker cotton. Simulation (decision support software) was developed to test hypotheses and to develop recommendations to assist cotton gin managers with engineering and management issues.

Introduction

The number of cotton gins in Texas has decreased from over 1400 in the early 1960s to less than 280 in 2006. At the same time, the production of cotton in Texas in 2004 and 2005 increased from an average of less than five million bales to over seven million bales (Parnell et al. 2006a). This increase in bales ginned in the 2004 and 2005 seasons seems to be continuing for this year. Many gins have had to process cotton for five to six months operating for 2000 to 3000 hours. A number of producers have had to transport their cotton long distances to reach operating gins. The combination of fewer gins and more cotton to gin with many gins operating longer gin seasons is serious. It is likely that this change in the production, transporting seed cotton, and processing of cotton in Texas is not temporary but is a significant change in the traditional harvesting/ginning system where seed cotton was delivered to the nearest gin and processed on a first-come, first-ginned queue discipline. These changes in the harvesting/ginning system present many problems for the principal decision makers (gin managers and cotton producers) in the cotton industry. This is not just a Texas problem but it is prevalent across the cotton belt.

On the surface, the simple solution is to build and operate bigger gins capable of processing cotton at faster rates. However, large gins must have a consistent supply of cotton from year-to-year to maintain the goal of minimum processing costs per bale. Parnell et al. (2005a) introduced the concept of developing decision support software using variable and fixed costs versus "percent Utilization" (%U) and reported that the total per bale costs increased significantly as the percent utilization dropped below 100%U.

Goals and Objectives
The goal of this research is to assist managers of cotton gins by developing simulation models and incorporating them into decision support software. The goal of the software is to provide answers for questions such as the following:

1. *What would be the ginning costs per bale if I were to increase my ginning rate by 50%?*
2. *What is the best strategy for operating my gin if I will have to gin for 2000 hours or more? Should it be the current 24 hours per day, seven days per week with two crews or should I use another plan?*
3. *What should producer pay for transporting seed cotton from the turn-row to the gin storage area? It is anticipated that producers will pay a per mile service charge for this service. How far should I transport cotton from the turn-row to the gin?*

Relationships for variable, fixed, and total costs per bale as functions of percent utilization have been developed from two economic gin surveys (Valco et al. 2003 and 2006) which contained over 100 gins and from over ten cooperating gins that provided economic data (Parnell et al. 2006a). Cotton gin variable costs (VC) were defined as follows: (1) seasonal labor, (2) electric power, (3) repairs and maintenance, (4) dryer fuel, (5) bagging and ties, (6) module hauling, and (7) tarps. Cotton gin fixed costs (FC) included: (1) interest on annuities, (2) depreciation, (3) taxes, shelter, and insurance (TSI), and (4) management (non-seasonal labor). Total costs per bale (TC/bale) were calculated by adding variable and fixed cost per bale.

Procedures

The basis for CGSM is variable and fixed cost per bale as a function of percent utilization (%U). The definition of %U is as follows:

$$\%U = GR * 0.8 * t \quad (1)$$

Where: GR = Rated ginning rate in bales per hour (bph);
0.8 = fraction corresponding to the equipment efficiency; and
t = hours of operation without downtime (1000 hours correspond to 100%U).

For example, if a gin rated at 30 bph gins at 100 %U, it would gin 24,000 bales (30*0.8*1000). If a gin is ginning at 50 %U, then the gin is processing cotton for 500 hours regardless of the size of gin. (Parnell et al. 2005a and 2006a)

With this modeling approach, variable cost per bale and total fixed cost versus %U should be constant. Typically, fixed cost per bale and total cost per bale plotted against %U decrease linearly as %U increases. In reality, fixed costs per bale and total costs per bale have relationships similar to a quadratic representation that reach a minimum cost (saddle point) at an optimal %U.

The variable and fixed costs came from two economic gin surveys (Valco et al. 2003 and 2006) which contained over 100 gins and from over ten cooperating gins that provided economic data (Parnell et al. 2006a). The survey data contained only variable costs. The economic data from the cooperating gins provided both variable and fixed costs.

The survey data was comprised of single year data points for each gin. The surveys contained variable costs that were collected from questionnaires filled out by ginners throughout Texas and a few from Oklahoma. This data did not include all seven variable costs. The economic data was collected from cooperating gins throughout the state of Texas. The data from the cooperating gins consisted of two to six years of economic data for each gin and contained all variable and fixed costs. The cooperating gins graciously opened up their books and the data collected was excellent. The survey data, as with all surveys, was very biased data (due to possible misinterpretation of the questions being asked), so more emphasis was put on the economic data than the survey data. Parnell et al. (2005a) divided gins into four gin size categories and reported each gin size category as different total cost per bale equations. We divided the gins from the survey into the four gin size categories: (1) 0-15 bph; (2) 15-25 bph; (3) 25-40 bph; and (4) >40 bph. The gin size categories were then used to derive total cost per bale equations from the survey data.

Cost relationships for each variable cost were determined by analyzing the survey data. Errors in the data were determined if the data given was considered infeasible. The data collected from the cooperating gins helped determine the feasibility of the data that was in the surveys. The data collected from the cooperating gins included financial statements which were considered more accurate than the survey data. If errors occurred, then we attempted to correct the data by back calculating. If there was not enough data to back calculate, the data points were thrown out. There were 102 gins left after the erroneous data was corrected or thrown out. Equations were derived for each variable cost from the survey data. The data from the cooperating gins was used to check the equations. Once the equations were checked, outliers were thrown out resulting in a total of 90 gins that were used from the survey data.

The only fixed cost that was contained in the survey data were the taxes and insurance aspect of TSI in the Valco et al. (2006) survey only. All fixed costs had to be calculated. Interest on annuities was calculated by using equation 2 (ASABE Standard EP496.3: FEB 2006, Section 6.2.2, Interest). We assumed an interest rate of 7%, a salvage rate of 15%, and 20 years of investment. Salvage value was determined by multiplying the purchase value by the salvage rate.

$$R = (P - S)\left[\frac{\left(\frac{i}{q}\right)}{1 - \left(1 + \frac{i}{q}\right)^{-nq}}\right] + S\left(\frac{i}{q}\right) \tag{2}$$

Where: R = one of a series of equal payments due at the end of each compounding period, q times per year;
P = principal amount;
i = annual interest rate in decimal;
q = compounding periods per year;
n = life of the investment in years; and
S = salvage value.

Depreciation (D) was calculated by using the straight-line depreciation method, equation 3. The principal amount of the equipment is represented by (P); the salvage value is represented by (S); and the life of the equipment is represented by (L). The life of equipment is usually described in years, but because more and more gins are ginning for 2,000 hours, twice the amount of time that the equipment was designed for, equipment was depreciated on an hourly basis which was assumed to be 15,000 hours. The same rates were used for depreciation that was used for the interest on annuities calculations.

$$D = \frac{P - S}{L} \tag{3}$$

Management (M) was calculated by using an equation that was acquired through a personal contact with Dr. Sergio Capareda at Texas A&M University where (B) represents the number of bales ginned in a season; (RF1) is a constant 5591.5; (%U) represents the percent utilization ginned by a gin in a specific season; and (RF2) is a constant 1.5 (equation 4). For example, if a 30 bph gin ginned 24,000 bales, this would be 100 %U and the cost of management would be calculated to be 24000 * 5591.5 * (100^-1.5) which equals $134,196. This equation only holds true if ‘RF1*(%U^{-RF2})’ is greater than $4.00, otherwise, assume $4.00 per bale. (Capareda, 2005)

$$M = B * RF1 * (\%U^{-RF2}) \tag{4}$$

Taxes, shelter, and insurance (TSI) was calculated by simply taking 2% of the principle value of the gin. For example, if a gin had a principle of $1,000,000 then TSI would equal $20,000 per year. This held pretty constant for the data provided to us from the cooperating gins.

Once the fixed costs were calculated for the survey data, each total fixed cost was divided by the total number of bales ginned for each gin. Total fixed cost per bale and total variable cost per bale were added together to get total cost per bale. Within the variable costs, average module hauling per bale was calculated to be about $4.00 per bale as shown in Table 1. This number was then replaced with the Simpson et al. (2007) model. This model calculates transportation costs (TC) on a per module basis as shown in equations 5a and 5b where (d) represents each mile over 15 miles that a module is transported. This equation determines that transportation costs per module and it was assumed that 15 bales of cotton could be ginned from each module. For example, if a module was transported from 30 miles, that transportation cost would be $108.75 per module, [60+3.25*(30-15)]. The transportation cost per bale was then calculated to be $7.25 per bale, ($108.75/15 bales).

$$TC = 60 \qquad \text{Where } d \leq 15 \text{ miles;} \tag{5a}$$

$$TC = 60 + 3.25*(d-15) \qquad \text{Where } d > 15 \text{ miles} \tag{5b}$$

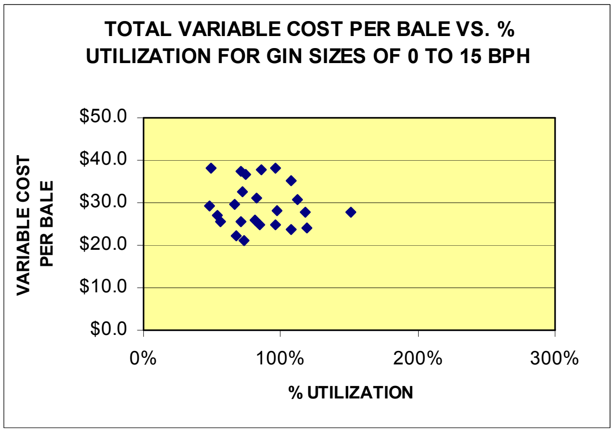
Results

The average variable costs per bale for each gin size category are listed in Table 1. The average cost of electric power, seasonal labor, and bagging & ties decreased with increasing gin size. Repairs and maintenance and drying costs seem to fluctuate or even increase for increasing gin size. It is difficult to make general statements about the average costs of the two categories “repair and maintenance” and “drying costs”. In wet harvesting seasons, the cost of drying seed cotton is significantly higher than in dry harvesting seasons. In addition, some gins use propane while others use natural gas. In the past natural gas drying was less expensive. Likewise, older gins will require more expenditures for “repair and maintenance” than newer gins. It is likely that larger gins have higher costs associated with repair and maintenance than smaller gins just because the equipment that breaks down is larger and more expensive. The variable costs associated with “tarps” and “module hauling” was approximated using the survey data from Valco et al. (2006) and the economic multi-year data. It is likely that these costs will vary significantly with varying %U (Tarps). Module Hauling, which is shown in table 1 to have a variable cost of $4.00 per bale actually depends on the yield per acre and the density of cotton fields in an area and is determined by using equation 5a and 5b.

Table 1. Average variable costs per bale for each gin size category. Averages were based upon Valco et al. (2003) and (2006) survey data except for the variable costs associated with “module hauling” and “tarps”. They were estimated from historical data from cooperating gins and the Valco et al. (2006) survey.

	Electric Power	Drying	Labor	Repairs & Maintenance	Bagging & Ties	Module Hauling	Tarps	Variable Cost per Bale
<15 bph	$4.00	$1.30	$10.20	$5.10	$3.60	$4.00	$1.10	$26.30
15-25 bph	$4.00	$1.20	$7.50	$4.10	$3.60	$4.00	$1.10	$25.50
25-40 bph	$3.90	$1.10	$7.20	$5.20	$3.40	$4.00	$1.10	$25.90
>40 bph	$3.20	$1.30	$5.50	$6.20	$3.20	$4.00	$1.10	$24.50

Figures 1a, 1b, 2a, and 2b show the total variable costs per bale plotted against percent utilization for each gin size category that was analyzed from the Valco survey data and the economic multi-year data. There are 24 gins from the Valco surveys plotted in figure 1a which are in the 0 to 15 bph gin size category. Figure 1b contains 31 gins from the Valco survey and five years of data from a 25 bph picker gin. Figure 2a consists of the 25 to 40 bph gin size category and contains 20 gins from the Valco surveys and three years of data from a 40 bph stripper gin. Figure 2b contains 15 gins from the Valco surveys, three years of data from a 60 bph stripper gin, and four years of data from a 60 bph picker gin. The average total variable cost per bale, as shown in table 1 and figures 1a, 1b, 2a, and 2b, is about $25 or $26.



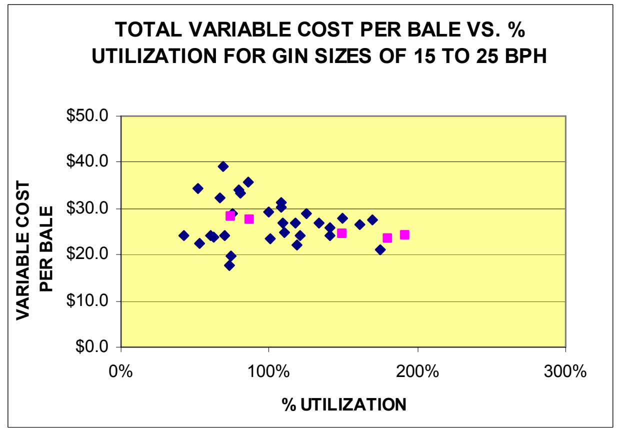
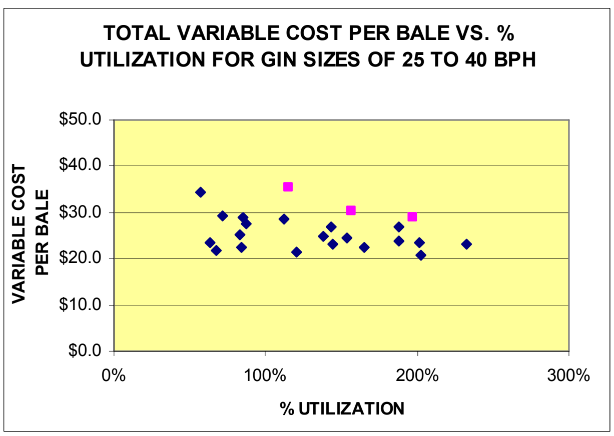


Figure 1a and 1b. Figures 1a and 1b represent scatter-plots, from the Valco surveys and the economic multi-year data, of the variable cost per bale for the 0-15 bph (Figure 1a) and the 15-25 bph (Figure 1b) gin size categories. They both average about $26 per bale. Figure 1a contains data from the survey data only, and figure 1b contains data from the surveys and a 25 bph picker gin.



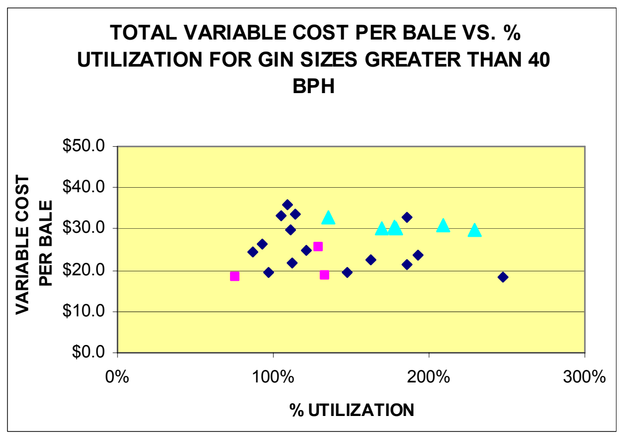


Figure 2a and 2b. Figures 2a and 2b represent scatter-plots of variable costs per bale for the 25-40 bph gin size category (Figure 2a) and for the >40 bph gin size category (Figure 2b). Figure 2a has an average variable cost per bale of about $26, and Figure 2b has an average variable cost per bale of about $25. Figure 2a contains survey data and a 40 bph stripper gin. Figure 2b contains survey data, a 60 bph stripper gin, and a 60 bph picker gin.

The variable cost per bale corresponding to module hauling had been approximated in previous reporting using a fixed $4/bale. In this paper, the module hauling costs per bale were determined using the Simpson model (Equation 5a and 5b). The procedure used to calculate the variable costs associated with module hauling consisted of determining the number of 15 bale modules in concentric 15 mile radii from the gin (15, 30, 45, 60 miles).The available cotton in the concentric rings was encoded in the GIS maps. A visual representation of transportation distances for a particular gin is shown in figure 3.

ArcGIS was used to develop maps that displayed transportation distances for seed cotton from the field to the gin. Figure 3 shows concentric rings with distances from less than 15 miles, 15 to 30 miles, 30 to 45 miles, 45 to 60 miles, and 60 to 100 miles. Data were inputted into GIS layers that included locations of every cotton field in the state of Texas with the corresponding area of each field. The locations and areas of the fields in the rings around a particular gin were used to calculate seed cotton available for the gin. For the purposes of this paper, it was assumed that all available seed cotton within a ring would be transported to the gin shown in figure 3 if needed to meet the specific %U. (In reality, a number of gins would compete for the seed cotton available for ginning in each concentric ring.) It was also assumed that the distance traveled for purposes of the Simpson model would be the distance to the outer ring. For example, the cost per module within 15 miles would be $60 or $4/bale at 15 bales per module. The cost per module in the 15 to 30 mile ring would be $60+$3.25*15=$109 or $7.25 per bale. The seed cotton available for ginning within the rings around a specific gin is independent of the ginning rate and %U used to obtain information for decision making.

The following is an example of how the seed cotton transportation costs could be calculated using the information included in the ArcGIS maps with the different layers: For our example, we have the following information:

- 30 bph gin operating at 200%U – 2000 hours ginning 48,000 bales;
- the gin transports and processes
    - 50% of its seed cotton within 15 miles,
    - 25% from 15 to 30 miles, and
    - 25% from 30 to 45 miles.
- Hence, 24,000 bales will be transported within 15 miles; 12,000 bales will be transported from 15 to 30 miles; and the remaining 12,000 bales will be transported from 30 to 45 miles, respectively.
- The cost per bale within 15 miles is $4. Hence, Transportation costs using equation 5a is $96,000;
- Using equation 5b, the cost per 15-bale module within the 15 to 30 mile concentric ring is $108.75 equal to $87,000 or $7.25 per bale;
- Using equation 5b, the cost per 15-bale module within the 30 to 45 mile concentric ring is $157.50 equal to $126,000 or $10.50 per bale;

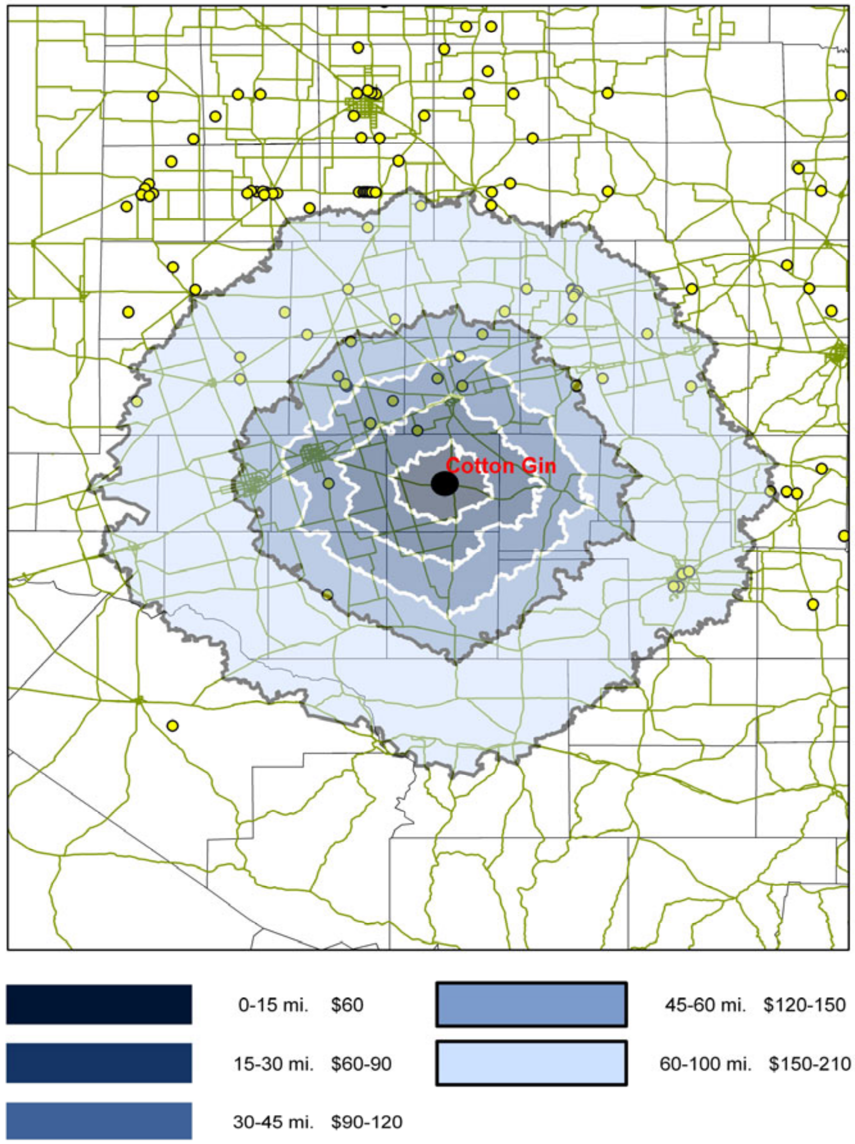


Figure 3. Figure 3 is an example of a map created in ArcGIS. Each circle represents transportation distances: 0-15 miles, 15-30 miles, 30-45 miles, 45-60 miles, and 60-100 miles. The distances were calculated from a road layer that was used in the ArcGIS software.

The methods used to estimate fixed costs were reported by Parnell et al. (2005a) and (2006a), and Simpson et al. (2004). The fixed cost per bale versus percent utilization equations for the different ginning rates (sizes) are shown in figures 4 through 7. Figure 4 shows data for 24 gins in the category 0 to 15 bph, with a majority of gins operating below 100 percent utilization.

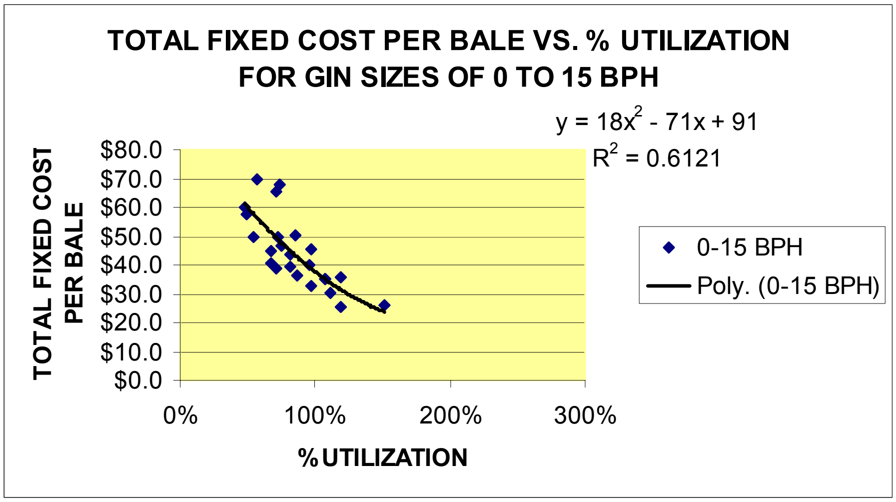


Figure 4. Total fixed cost per bale versus percent utilization for combined survey data (Valco et al. 2003 and 2006). The total number of gins in this category was 24.

The slope of the total fixed cost per bale from 0%U to 100%U is high. This result illustrates that the per bale ginning costs increases rapidly as the %U decreases from the optimum %U. For example, at 50%U, the fixed cost per bale would be approximately $60/bale; at 150%U, the fixed cost per bale would be approximately $25/bale .These high ginning costs at low %U may be partially responsible for the reduction in numbers of smaller gins. The optimum operating point for total cost per bale versus %U was estimated to occur at 170%U. Most gins surveyed in this gin size category were operating at levels of less than 150 %U, so the predicting a minimum cost per bale is an approximation.

Figure 5 shows the results of the analysis of fixed cost data versus %U for gins ranging in size from 15 to 25 bph. The total fixed cost per bale was less variable and the slope of the line from 50 to 100 %U was less than that for gins less than 15 bph (figure 1).

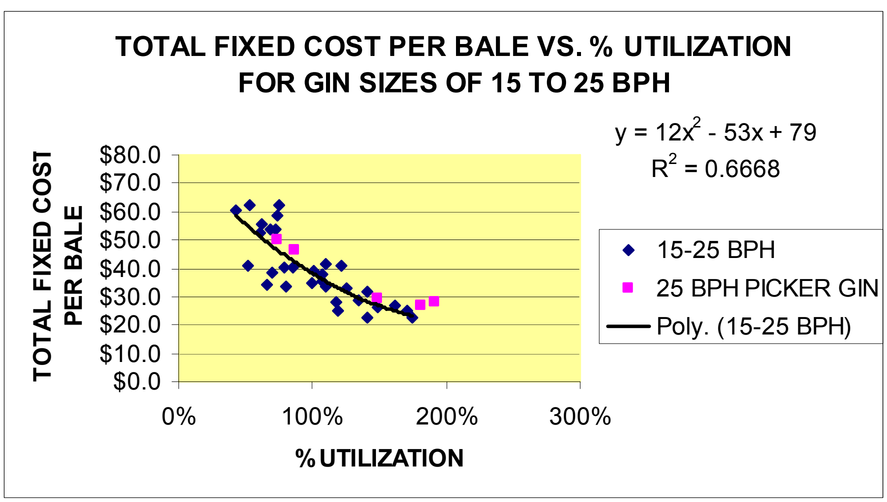


Figure 5. Total fixed cost per bale versus percent utilization for 31 gins from the survey data (Valco et al. 2003 and 2006) and 5 years of historical data from a 25 bph picker gin.

Many of the 31 gins in this category achieved over 100 %U and some approached 200 %U. The optimal operating point for gins in this category was estimated to be 180 %U. We included five years of historical data for a 25 bph picker gin that was in this size range. The historical data closely followed the trend line calculated from the survey data.

Figure 6 shows the results of the analysis of total fixed cost per bale data versus %U for gins in the size category of 25 to 40 bph. Many of the survey gins were operating at higher than 100%U. A few of these gins exceeded 200 %U. The optimal operating point determined for this gin size category was estimated to be 190 %U.

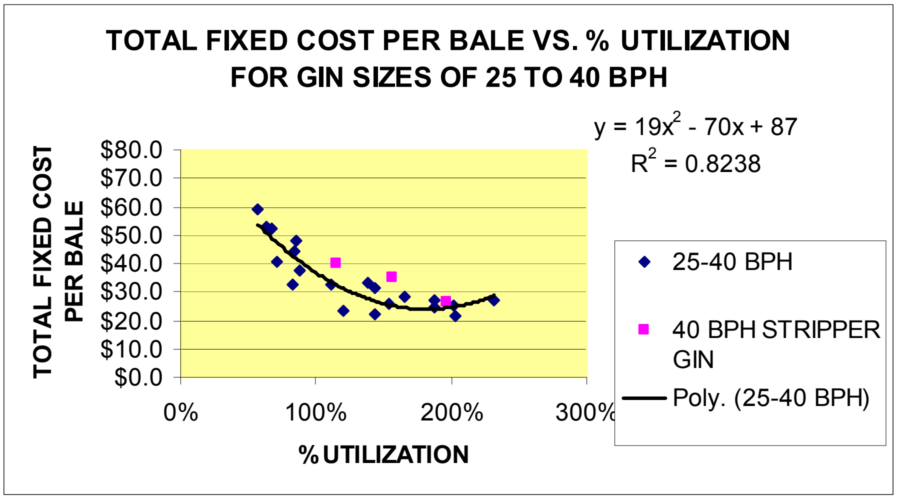


Figure 6. Total fixed cost per bale versus percent utilization for survey data (Valco et al. 2003 and 2006). Survey data from a total of 20 gins were included. Also displayed are historical data for 30 and 40 bph gins processing stripper cotton. The historical data closely followed the trend line calculated from the survey data.

The procedure used to estimate the optimum operating point was to force a quadratic equation to fit the data. As a consequence, the fixed cost per bale increases as the %U goes beyond the optimum %U. In reality, the data used to fit the quadratic equation was primarily from survey data of gins operating at less than optimum %U. There is a logical expectation that the ginning cost per bale should increase beyond the optimum %U. One would expect an increase in repairs and maintenance as equipment wears out and an increase in labor costs as the crews get tired ginning for five to six months at 24-hours per day 7-days per week . However, the total cost per bale as a function of %U is not necessarily going to be best described as a quadratic equation beyond the optimum %U.

Gins that were rated at greater than 40 bph (Figure 7) consistently operated between 100 and 200 percent utilization with several of the gins operating in excess of 200 %U. The total fixed cost per bale equation was derived from the 2003 and 2006 Valco survey data, plus 5 and 6 years of historical data from 60 bph gins processing stripper and picker cotton, respectively.

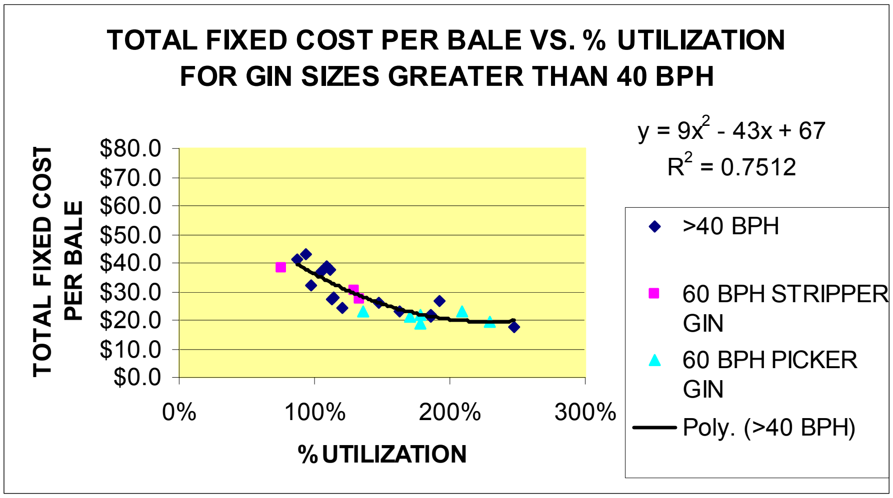


Figure 7. Total fixed cost per bale versus percent utilization for survey data (Valco et al. 2003 and 2006). Data from a total of 15 gins were included. Also displayed are 5 years of historical data for a 60 bph gin processing stripper cotton and 6 years for a 60 bph gin processing picked cotton. The historical data closely follows the trend line calculated from the survey data.

The optimal operating point was between 150 and 250 %U. The optimum operating point for gins in this category was not as well defined as with the previous ginning rate categories because the quadratic equation used to fit the data was flatter than the other three gin size categories. It was estimated to be 200%.

The fixed and variable costs per bale described by the equations shown in figures 1a, 1b, 2a, 2b, 4, 5, 6, and 7 were combined for estimating the total cost per bale of cotton ginned. The following scenarios are used to illustrate how these data and CGSM decision support software may be used to provide data for decisions making:

Scenario #1:

Ginner Jones has a 30 bph gin that has historically averaged 24,000 bales. However, in 2004 and 2005, he ginned 48,000 bales. He had been accustomed to operating 1000 hours (100%U) prior to the two big years. The two big years he and his crew had to operate 2000 hours (200%U). He is considering expanding his gin to a 45 bph gin in anticipation that he would continue ginning 48,000 bales in the future. His plan would be to operate at 133 %U (1,333 hours) to gin the 48,000 bales. He is concerned that the investment in increasing the ginning rate may present a problem if he is asked to only gin 24,000 bales in the future. Figures 8 and 9 illustrate the results of using CGSM decision support software. The findings are as follows:

- The total cost per bale to gin 24,000 bales for the 30 bph gin (100%U and 1000 hours) is $62.
- If the gin processing 24,000 bales had been expanded to 45 bph (0.7 %U and 700 hours), the cost per bale would be $67.
- The increase cost of ginning 24,000 bales was $20,000.
- If the 30 bph gin processed 48,000 bales (200%U and 2000 hours), the cost per bale would be $49.
- Had the gin been expanded to 45 bph and processed 48,000 bales (133 %U and 1300 hours), the cost per bale would be $50.
- There is approximately a $60,000 increase in ginning with the new (45bph) gin processing 48,000 bales per season compared to the old 30bph) gin.. (Operating the new gin at 133 %U, is not operating it at the optimum %U.)

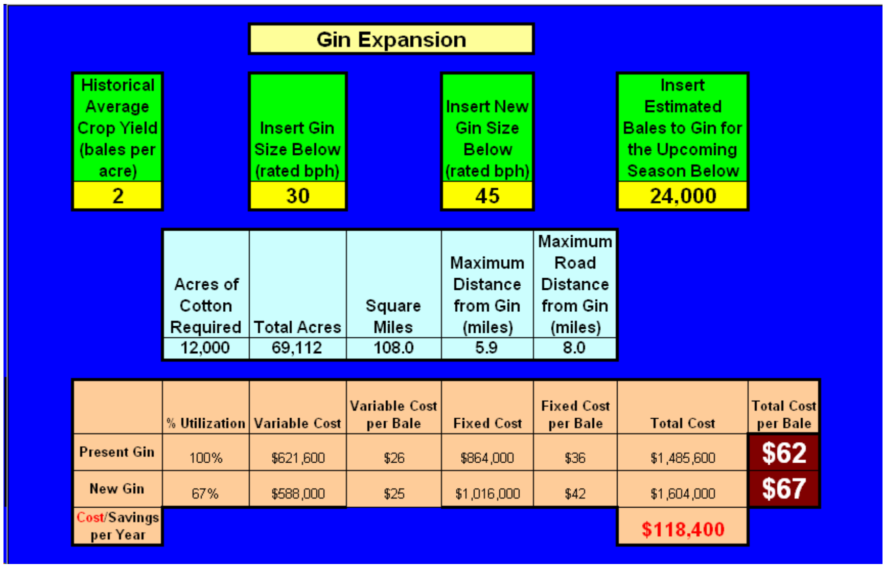


Figure 8. Results of CGSM analysis for scenario #1 with a 30 bph and a 45 bph gin processing 24,000 bales. The 45 bph (new) gin operating at 67 %U (670 hours) would require $5 per bale or $118,400 per season more than if the cotton had been processed by the 30 bph gin operating at 100 %U (1000hours).

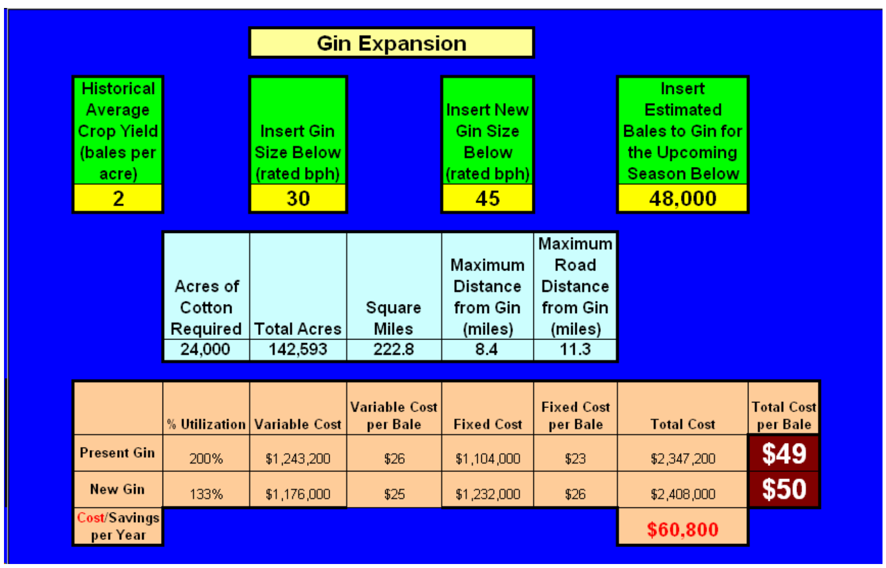


Figure 9. Results of CGSM analysis for scenario #1 with a 30 bph and a 45 bph gin processing 48,000 bales. The 45 bph (new) gin operating at 133 %U (1330hours) would require $1 per bale or $61,000 per season more than if the cotton had been processed by the 30 bph gin operating at 200 %U (2000hours).

<u>Scenario #2:</u>

Ginner Smith has a 50 bph gin that has historically averaged 40,000 bales. However, in 2004 and 2005, he ginned 80,000 bales. He had been accustomed to operating 1000 hours (100%U) prior to the two big years. The two big years he and his crew had to operate 2000 hours (200%U). He is considering expanding his gin to a 75 bph gin in anticipation that he would continue ginning 80,000 bales in the future. His plan would be to operate at 133 %U (1,333 hours) to gin the 80,000 bales. He is concerned that the investment in increasing the ginning rate may present a problem if he is asked to only gin 40,000 bales in the future. Figures 10 and 11 illustrate the results of using CGSM decision support software. The findings are as follows:

- The total cost per bale to gin 40,000 bales for the 50bph gin (100%U and 1000 hours) is $58.
- If the gin processing 40,000 bales had been expanded to 75bph (0.7 %U and 700 hours), the cost per bale would be $67.
- The increase cost of ginning 40,000 bales with the new gin would be $370,000.
- If the 50 bph gin processed 80,000 bales (200%U and 2000 hours), the cost per bale would be $42.
- Had the gin been expanded to 75 bph and processed 80,000 bales (133 %U and 1300 hours), the cost per bale would be $50.
- The additional ginning costs associated with the new (75bph) gin processing 80,000 bales at 133 %U (1300 hours) compared to the old (50bph) would be almost $700,000. (Operating the new gin at 133 %U, is not operating it at the optimum %U.)

Gin Expansion

Historical Average Crop Yield (bales per acre)	Insert Gin Size Below (rated bph)	Insert New Gin Size Below (rated bph)	Insert Estimated Bales to Gin for the Upcoming Season Below
2	50	75	40,000

Acres of Cotton Required	Total Acres	Square Miles	Maximum Distance from Gin (miles)	Maximum Road Distance from Gin (miles)
20,000	117,859	184.2	7.7	10.3

	% Utilization	Variable Cost	Variable Cost per Bale	Fixed Cost	Fixed Cost per Bale	Total Cost	Total Cost per Bale
Present Gin	100%	$980,000	$25	$1,320,000	$33	$2,300,000	$58
New Gin	67%	$980,000	$25	$1,693,333	$42	$2,673,333	$67
Cost/Savings per Year						$373,333	

Figure 10. Results of CGSM analysis for scenario #2 with a 50 bph and a 75 bph gin processing 40,000 bales. The 75 bph (new) gin operating at 67 %U (670 hours) would require $9 per bale or $373,000 per season more than if the cotton had been processed by the 50 bph gin operating at 100 %U (1000hours).

Gin Expansion

Historical Average Crop Yield (bales per acre)	Insert Gin Size Below (rated bph)	Insert New Gin Size Below (rated bph)	Insert Estimated Bales to Gin for the Upcoming Season Below
2	50	75	80,000

Acres of Cotton Required	Total Acres	Square Miles	Maximum Distance from Gin (miles)	Maximum Road Distance from Gin (miles)
40,000	243,169	380.0	11.0	14.6

	% Utilization	Variable Cost	Variable Cost per Bale	Fixed Cost	Fixed Cost per Bale	Total Cost	Total Cost per Bale
Present Gin	200%	$1,960,000	$25	$1,360,000	$17	$3,320,000	$42
New Gin	133%	$1,960,000	$25	$2,053,333	$26	$4,013,333	$50
Cost/Savings per Year						$693,333	

Figure 11. Results of CGSM analysis for scenario #2 with a 50 bph and a 75 bph gin processing 80,000 bales. The 75 bph (new) gin operating at 133 %U (1,3000hours) would require $8 per bale or $700,000 per season more than if the cotton had been processed by the 50 bph gin operating at 200 %U (2,000hours).

Future Work

Our future work on this project includes the following:

- Develop a better algorithm for calculating the variable and fixed cost per bale for %U beyond the optimum. It is anticipated that the repair and maintenance and seasonal labor beyond the optimum %U will significantly increase and may be better described mathematically by a non-quadratic relationship.
- Publish a paper on seed cotton transportation costs from the turn-row to the gin. (We have made significant progress with the coding of cotton farms and corresponding areas the state in our GIS system. The protocol using this information and the Simpson model need to be published. We plan to incorporate an additional discrete probability distribution describing the distribution of seed cotton available in the concentric rings.
- Acquire additional data from cooperators in the state and incorporate this new data into our results.
- Perform a critical evaluation into the procedures used for calculating fixed costs per bale. Consider accounting for the age of the gin.
- It is likely the assumption that the variable cost per bale is fixed and constant will change as we incorporate the Simpson model for transportation costs to acquire seed cotton larger distances from the gin, increases in seasonal labor beyond the optimum, and increases in repair and maintenance for long gin seasons.

References

ASABE Standards. February, 2006. EP496.3: Agricultural Machinery Management. ASABE; St. Joseph, Michigan.

Capareda, S. C.; 2005. Personal communication. BAEN Department; Texas A&M University, College Station, Texas.

Parnell, C. B., Jr., S. L. Simpson, S. A. Emsoff, J. D. Wanjura, B. W. Shaw, and S. C. Capareda. 2006a. Systems engineering of seed cotton handling and ginning in Texas. Paper presented at the 2006 ASABE/CSAE Annual International Meeting held July 9-12, 2006; Portland, Oregon. Paper No. 061020. ASABE, St. Joseph, Michigan.

Parnell, C. B., Jr., B. W. Shaw, S. L. Simpson, S. C. Capareda, S. A. Emsoff, and N. A. Roberson. 2006b. Systems engineering of seed cotton handling and ginning in Texas. Paper presented at the 2006 Beltwide Cotton Conference meeting held January 11-13, 2006 in San Antonio, Texas. National Cotton Council Beltwide Cotton Conference, Memphis, Tennessee.

Parnell, C. B., Jr., B. W. Shaw, S. L. Simpson, S. C. Capareda, J. W. Wanjura, and S. A. Emsoff. 2005a. Systems engineering of cotton production and ginning in Texas. Paper presented at the 2005 ASAE/CSAE Annual International Meeting held July17-20, 2005; Tampa, Florida. Paper No. 051097. ASAE, St. Joseph, Michigan.

Parnell, C. B., Jr., S. L. Simpson, S. C. Capareda, and B. W. Shaw. 2005b. Seed cotton transport and ginning – system analysis. Paper presented at the 2005 Beltwide Cotton Conference meeting held January 4-7, 2005 in New Orleans, Louisiana. National Cotton Council Beltwide Cotton Conference, Memphis, Tennessee.

Simpson, S. L., L. B. Goodrich, M. T. Hamann, C. B. Parnell, Jr., S. C. Capareda, and B. W. Shaw. 2007. Engineering of Seed Cotton Transport Alternatives. Paper presented at the 2007 Beltwide Cotton Conference meeting held January 9-12, 2007 in New Orleans, Louisiana. National Cotton Council Beltwide Cotton Conference, Memphis, Tennessee.

Simpson, S. L., C. B. Parnell, Jr., and S. W. Searcy. 2004. Systems analysis of ginning seasons and seed cotton transport. Paper presented at the 2004 Beltwide Cotton Conference meeting held January 5-9, 2004 in San Antonio, Texas. National Cotton Council Beltwide Cotton Conference, Memphis, Tennessee.

Valco, T. D., K. Green, T. L. Price, D. S. Findley, and R. A. Isom. 2006. Cost of ginning cotton – 2004 survey results. Paper presented at the 2006 Beltwide Cotton Conference meeting held January 11-13, 2006 in San Antonio, Texas. National Cotton Council Beltwide Cotton Conference, Memphis, Tennessee.

Valco, T.D., B. Collins, D.S. Findley, K. Green, T. Lee, R. A. Isom, and M. H. Willcutt. 2003. The cost of ginning cotton – 2001 survey results. Paper presented at the 2003 Beltwide Conference meeting held January 6-10, 2 003 in Nashville, Tennessee. National Cotton Council Beltwide Cotton Conference, Memphis, Tennessee.