ECONOMIC ANALYSIS OF TRANSPORTING SEED COTTON WITH SEMI TRACTOR TRAILERS

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Abstract

The number of cotton gins in the state of Texas has declined from over 1400 gins in 1960 to less than 280 in 2007. Cotton production in the state of Texas has been steady with the exception of three of the last four years when production has exceeded 7 million bales for the first three times in history. These figures have meant that gins are typically growing in size, running longer seasons, and traveling farther to retrieve seed cotton. Decision support software has been developed to aid in observing the effects of these three circumstances for both producers and ginners. The effects of rising fuel costs as well as the benefits of transportation using semi tractor trailers (STT) are considered. The design of a semi trailer capable of transporting two modules per trip is detailed. The trailer is sixty eight feet long and uses a walking floor system to load and unload modules. Economic analysis of using a STT for transport assumes that the producer covers the costs of loading the STT at planned staging areas, each of which has its own coverage area. For distances within 30 miles of the gin, conventional module trucks are assumed to be utilized. Distances greater than thirty miles immediately display the advantages of using the STT in lieu of the module truck.

Introduction

The number of cotton gins in Texas has decreased from over 1400 in the early 1960s to less than 280 in 2007. Meanwhile, the production of cotton in the state has remained fairly consistent and actually grown from an average of five million bales to exceed seven million bales in three of the last four years. The typical gin has grown drastically in size, and the average ginning season has increased in length. Also, some areas of the state have grown more isolated from cotton gins. As gins continue to close their doors in some areas of the state, distance to the nearest gin and the cost of transporting seed cotton becomes an increasingly important consideration. As the distance of seed cotton transportation from field to gin has increased, fuel prices have become an important factor in the total transportation cost equation. Prices for diesel fuel have risen steadily in recent years and influence the cost per bale of transportation. As gin managers consider retrieving cotton modules from areas at ever growing distances from their gins, projected costs and alternatives to current transportation practices should be considered. In the same respect, producers should be able to estimate the cost per bale associated with transportation and what factors will play a role in changes to this value.

The majority of cotton produced in America is placed in modules measuring 8 feet wide, 32 feet long, and 8 feet tall. Modules are built on the ground in a place selected for its height, proximity to the edge of the field or to the road, or other considerations. These modules are transported to the gin of choice by a module truck as the gin becomes able to place them on its yard. This may take several months in some cases. Module trucks are typically bobtail rigs with tandem rear axles and tilting chain-floor beds capable of backing themselves underneath modules and conveying them onto the bed of the truck. The bed is typically between thirty five and forty feet long, weighs around 16,000 pounds and costs up to $70,000. When combined with the truck, the system weighs around 32,000 pounds (McCarlos, 2007). When a module, typically weighing 18,000 – 22,500 pounds, is loaded onto one of these trucks, the combined axle load exceeds the allowable limit of 34,000 pounds per tandem axle set allowable for transport using the Dwight D. Eisenhower System of Interstate and Defense Highways (Interstate System) (DOT, 2007). While affected states have exceptions for these trucks, they do not apply to the Interstate System, thus module trucks must either avoid interstate highways or face being fined.

Transportation Alternatives

A module truck is a proven and effective way to move modules over short distances from fields. It would be hard for a system capable of transporting more than one module to take the place of a module truck because a module truck is designed favorably for entering and leaving fields and for loading and unloading modules. However, the truck is specialized and relatively expensive. Over longer distances, it may be more cost-effective to be able to carry more than one module at a time.

An option that has been explored by some ginners is transporting modules from some of their farthest fields to the gin using semi tractor trailers. These systems consist of a semi tractor pulling a trailer capable of hauling one and a half modules at a time, therefore increasing productivity by 50%. A semi tractor can be used for many applications and would be less costly than a module truck. A trailer capable of carrying the load would be of standard size and also be easily obtained. A disadvantage to this system, along with being harder to load, is that a conventional module and half of another must be used. This requires modification of a module builder. This system would, however, work well with new on-board module building systems from Deere and Case IH as both make modules that can be configured to take up half of the space of a conventional module. It is also legal for semi tractors to travel on all highways, including interstate highways, and a decrease in transportation time may be expected.

A third method consists of a semi tractor pulling a trailer capable of carrying two modules. This would require a specialized trailer to be built which would be over the legal limit for length, but a permit may be acquired to allow use on interstate highways. The trailer would be more expensive and would require additional permitting costs but may be more cost effective than the semi tractor trailer hauling one and a half modules over long distances.

Simpson et al. (2007) developed a model for calculating transportation costs associated with module trucks. Assumptions were made for various costs including: purchase of used truck, labor, fuel, maintenance, license, insurance, fuel use, shift time, truck speed, amount of cotton per load, and loading/unloading time. The Simpson et al, (2007) model assumed a straight-line depreciation over 10 years and accounted for differences in stripper and picker cotton as well as changes in costs. Fuel costs have been adjusted to reflect recent price activity and hours worked per day have been adjusted from ten to twelve. All assumptions made were as follows:

- A used module truck will cost $50,000 @ 6% interest for a 5 year period;
- Straight line depreciation of the module truck over 10 years;
- Fuel mileage of 5 mpg;
- Diesel cost @ $3.00/gal;
- Module truck average speed 45 mph;
- Maintenance costs $1000/yr;
- Insurance costs $1000/yr;
- License cost $500;
- Driver can work a 12 hour day and is paid $15 per hour including benefits;
- Module weighs 22,500 pounds per load;
- 15 bales per module for picker cotton;
- 12 bales per module for stripper cotton; and
- 1 hour loading & unloading time per module.

This model has been adapted to fit a semi tractor trailer hauling either one-and-a-half or two modules. First, the cost of a used semi tractor is assumed to be $25,000. A simple tractor with tandem rear axles and a cab with no sleeper, weighing up to 16,000 pounds is used. A trailer with a live floor and a length of 53 feet is assumed to cost $50,000. A trailer long enough to carry two modules would be 68 feet long and would need to be specially built. This trailer is assumed to cost $80,000 and is discussed in further detail below. A permit for this truck would cost no more than $2000 in Texas and would likely bear a similar cost in other states (TXDOT, 2007). Average speed for both trucks is assumed to increase from 45 mph to 50 mph and loading and unloading times total 2 hours per trip.

It was assumed that a trailer 68 feet long, because of difficulty of reversing and the extreme weight requirements of a trailer capable of tilting to the ground while carrying 45,000 pounds, would need be loaded by a separate machine. In most cases this would be a standard module truck. Several flooring alternatives were considered for use in a trailer capable of hauling two modules. The first was a standard flat trailer that would require a module truck to be driven onto the trailer to load it. It would not be feasible to construct a ramp to load this trailer at all locations necessary. The next alternative was a chain floor. This would allow a trailer to be placed with its rear end against a module truck and the floors to move at a synchronized speed as the module is moved from one truck to the other. However, this trailer would be very heavy (close to double the 16,000 lb. bed of a conventional module truck). The third alternative considered is a walking floor trailer. This trailer would be completely covered, and would have the same type of moving floor as is used in many gin feeding operations. As observed by Dean, et al. (2007), the floor does little damage to the module as it is moved. The floor would move slowly but, because of weight considerations, was selected for this analysis. A 68 foot walking floor trailer would need to be custom-built at a cost of $80,000 but would likely weigh only 17,000 pounds (Cloud, 2007). Assuming two modules weighing 22,500 lb each, a semi tractor weighing 16,000 lb, and a trailer weighing 17,000 lb., the total weight of the loaded STT would be 78,000 pounds and would remain below the 80,000 pound limit for a semi tractor trailer traveling on the interstate system (DOT, 2007). Therefore, it would not require an overweight permit.

It was determined that the cost of having a constant module truck support team for the semi tractor trailer prohibited doing such. The most desirable system would be a set of staging areas placed at several locations to which the semi tractor trailer would travel to be loaded. Several sites with a radius of up to fifteen miles could be maintained, with module trucks paid for by producers keeping them full of modules and loading the STT as it arrived. The STT would then carry the load back to the gin where a truck on the yard, normally used to supply modules to the feeder, would unload it. Such a system would not be cost-effective inside of a thirty mile radius when compared to simply using a standard module truck for transportation.

Decision Support Software for Transportation Analysis

Decision support software was developed to help producers and ginners analyze costs associated with transportation. With the assumptions previously made for the costs of a module truck and both STT concepts, different scenarios can be compared. Figure 1 shows a sample of the program considering a module truck carrying spindle-picked cotton modules. Variables such as fuel price, fuel economy, and modules per trip can be changed easily and the effect on cost per bale observed.

Miles/year	25,000		Fuel	$3.00	/gal
Cost of Truck	$50,000		Fuel Economy	5	mpg
Labor (driver)	$15	/hr	Bales/module	15	
Avg Speed	45	mph	Modules/trip	1	
Load/unload time	1.0	hr	lbs/load	22500	
Driver	12	hrs/day			
			--Fixed Costs		
			--Variable Costs		

60 bph	1	2	3	4
Machine:	100% Utilization	150% Utilization	200% Utilization	250% Utilization
Bales/season	48,000	72,000	96,000	120,000
Maintenance	$1,000	$1,000	$1,000	$1,000
License/Permit Fee	$500	$500	$500	$500
Insurance	$1,000	$1,000	$1,000	$1,000
Payment/yr truck	$11,870	$11,870	$11,870	$11,870
Depreciation	$4,500	$4,500	$4,500	$4,500
Total FC	$18,870	$18,870	$18,870	$18,870
FC/mile	$0.75	$0.75	$0.75	$0.75
FC/trip (module) - 15 miles outer distance	$23	$23	$23	$23
Labor - 15 miles	$25	$25	$25	$25
Fuel - 15 Miles one way	$18	$18	$18	$18
Fuel/mile	$0.60	$0.60	$0.60	$0.60
Total VC - 15 miles one way	$43	$43	$43	$43
VC/mile (one way distance)	$2.87	$2.87	$2.87	$2.87
Total Cost/trip - 15 miles one way	$66	$66	$66	$66

How much cotton do we gin?

	100%	150%	200%	250%
0-15	50%	33%	25%	34%
15-30	50%	33%	25%	20%
30-45	0%	33%	25%	20%
45-60	0%	0%	25%	20%
60-100	0%	0%	0%	6%

	100%	150%	200%	250%	100%	150%	200%	250%
0-15	24000	24000	24000	40800	$82,097	$82,097	$82,097	$139,564
15-30	24000	24000	24000	24000	$139,430	$139,430	$139,430	$139,430
30-45	0	24000	24000	24000	$0	$208,230	$208,230	$208,230
45-60	0	0	24000	24000	$0	$0	$277,030	$277,030
60-100	0	0	0	7200	$0	$0	$0	$120,949
			Cost/bale		$4.62	$5.97	$7.36	$7.38

Figure 1. Example of model analysis for truck transporting picker modules.

For distances from zero to fifteen miles from the gin, the cost per trip is represented by the total cost/trip line of the table, a total of the variable and fixed costs for the distance. For modules more than fifteen miles from the gin, the formula is represented by equation 1:

$$CT = TC + (D-15) * VC \quad (1)$$

Where: TC = Total cost per 15 mile trip
D = One-way distance to module
VC = Variable cost per mile
CT = Cost of the trip

The software also considers different utilization percentages, as defined by equation 2:

$$\%U = GR * 0.8 * t \quad (2)$$

Where: GR = Rated ginning rate in bales per hour (bph);
0.8 = assumed equipment efficiency; and
t = hours of operation without downtime (1000 hours correspond to 100%U) (Parnell et al, 2005).

Figure 2 illustrates how percent utilization (%U) is utilized along with ginning capacity. As the %U increases, the number of bales of cotton expected from within a certain range of distance from the gin change. As the composition of this supply is changed, the number of days of operation for one truck inside of each range is listed. If the number of days per season of transport exceeds the number of days per season of gin operation, more than one truck will be required to complete the transportation of cotton from that range.

60 bph	1	2	3	4
Machine:	100% Utilization	150% Utilization	200% Utilization	250% Utilization
Bales/season	48,000	72,000	96,000	120,000
Maintenance	$1,000	$1,000	$1,000	$1,000
License/Permit Fee	$500	$500	$500	$500
Insurance	$1,000	$1,000	$1,000	$1,000
Payment/yr truck	$11,870	$11,870	$11,870	$11,870
Depreciation	$4,500	$4,500	$4,500	$4,500
Total FC	$18,870	$18,870	$18,870	$18,870
FC/mile	$0.75	$0.75	$0.75	$0.75
FC/trip (module) - 15 miles outer distance	$23	$23	$23	$23
Labor - 15 miles	$25	$25	$25	$25
Fuel - 15 Miles one way	$18	$18	$18	$18
Fuel/mile	$0.60	$0.60	$0.60	$0.60
Total VC - 15 miles one way	$43	$43	$43	$43
VC/mile (one way distance)	$2.87	$2.87	$2.87	$2.87
Total Cost/trip - 15 miles one way	$66	$66	$66	$66
30				
Trips/day	5	5	5	5
Bales/day	75	75	75	75
Days/season for transport	32	240	256	320
Cost/bale	$7.24	$7.24	$7.24	$7.24
Total Cost/season	$17,383	$130,373	$139,064	$173,830
45				
Trips/day	4	4	4	4
Bales/day	60	60	60	60
Days/season for transport	40	300	320	400
Cost/bale	$10.11	$10.11	$10.11	$10.11
Total Cost/season	$24,263	$181,973	$194,104	$242,630
60				
Trips/day	3	3	3	3
Bales/day	45	45	45	45
Days/season for transport	53	400	427	533
Cost/bale	$12.98	$12.98	$12.98	$12.98
Total Cost/season	$31,143	$233,573	$249,144	$311,430

	100%	150%	200%	250%
0-15	50%	40%	30%	34%
15-30	45%	35%	25%	20%
30-45	5%	25%	20%	20%
45-60	0%	0%	25%	20%
60-10(	0%	0%	0%	6%

	100%	150%	200%	250%
0-15	24000	28800	28800	40800
15-30	21600	25200	24000	24000
30-45	2400	18000	19200	24000
45-60	0	0	24000	24000
60-10(	0	0	0	7200
			Cost/bale	

Figure 2. Costs for various ranges of distance for picker module truck.

The average cost per bale versus percent utilization for both a picker module truck and a picker STT carrying two modules are shown in Figures 3 and 4, respectively. As the percent breakdown of cotton from differing ranges is manipulated, the number of bales gathered from each region changes as defined by the number of bales per hour the gin is capable of processing. The total cost for all bales transported from each region is displayed to the right, and the average price per bale for each breakdown in %U is displayed at the bottom. The costs for cotton inside of thirty miles are the same because it was assumed that a module truck would gather all of these modules. The STT is more cost effective as the distance from the gin increases. The decision support software assumes the STT is loaded by a module truck whose operation is funded by the producer.

	100%	150%	200%	250%
0-15	50%	40%	30%	34%
15-30	45%	35%	25%	20%
30-45	5%	25%	20%	20%
45-60	0%	0%	25%	20%
60-100	0%	0%	0%	6%

	100%	150%	200%	250%	100%	150%	200%	250%
0-15	24000	28800	28800	40800	$82,097	$98,516	$98,516	$139,564
15-30	21600	25200	24000	24000	$125,487	$146,402	$139,430	$139,430
30-45	2400	18000	19200	24000	$20,823	$156,173	$166,584	$208,230
45-60	0	0	24000	24000	$0	$0	$277,030	$277,030
60-100	0	0	0	7200	$0	$0	$0	$120,949
			Cost/bale		$4.76	$5.57	$7.10	$7.38

Figure 3. Average cost per bale - module truck.

	100%	150%	200%	250%
0-15	50%	40%	30%	34%
15-30	45%	35%	25%	20%
30-45	5%	25%	20%	20%
45-60	0%	0%	25%	20%
60-100	0%	0%	0%	6%

	100%	150%	200%	250%	100%	150%	200%	250%
0-15	24000	28800	28800	40800	$82,097	$98,516	$98,516	$139,564
15-30	21600	25200	24000	24000	$125,487	$146,402	$139,430	$139,430
30-45	2400	18000	19200	24000	$15,132	$113,491	$121,057	$151,322
45-60	0	0	24000	24000	$0	$0	$196,922	$196,922
60-100	0	0	0	7200	$0	$0	$0	$84,156
			Cost/bale		$4.64	$4.98	$5.79	$5.93

Figure 4. Average cost per bale - STT.

Fuel Costs

The effect of fuel price on the cost of transportation is increasingly critical. As fuel prices rise, so must the cost of transporting seed cotton to gins. Assuming both methods of transportation achieve the same fuel economy and an STT carrying twice the amount of cotton, the cost of transportation with a module truck is twice as sensitive to the price of fuel compared to the STT. The cost of transportation per bale for a module truck versus an STT for fuel prices of $2.50 and $4.00 per gallon is shown in Figure 5. The transportation cost per bale at a distance of 30 miles for the module truck and the STT for fuel prices ranging from $2/gal to $4/gal is shown in Figure 6. Again, the cost of transporation for the module truck is more sensitive to changes in fuel prices than the STT. At a distance of 30 miles, a $0.10/gal increase in fuel price corresponds to an increase in transportation costs of $0.08/bale for a module truck; for a STT, the increase is $0.04/bale. At 60 miles, the increase is $0.16/bale carried by a module truck for every $0.10/gal versus only $0.08/bale for the STT.

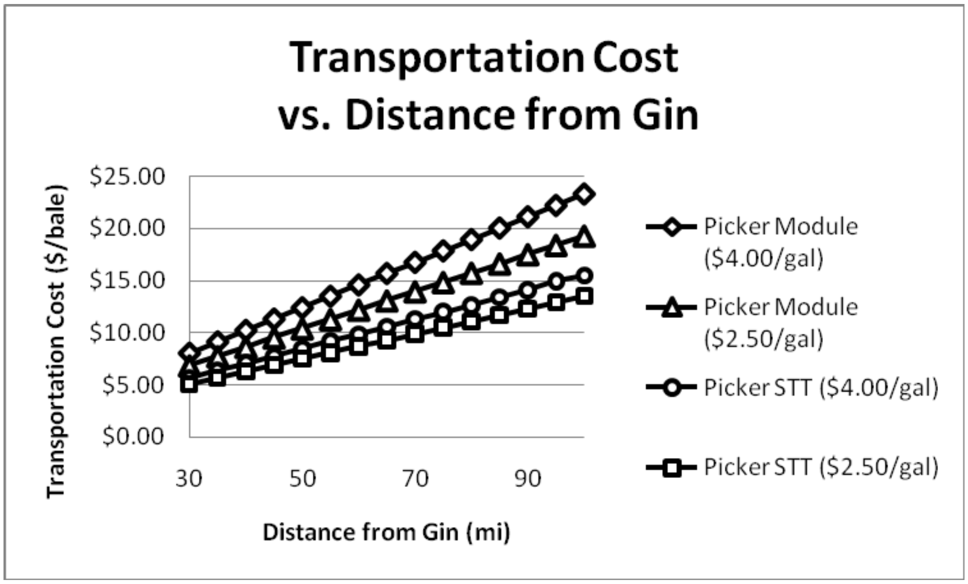

Figure 5. Transportation cost vs. distance from gin.

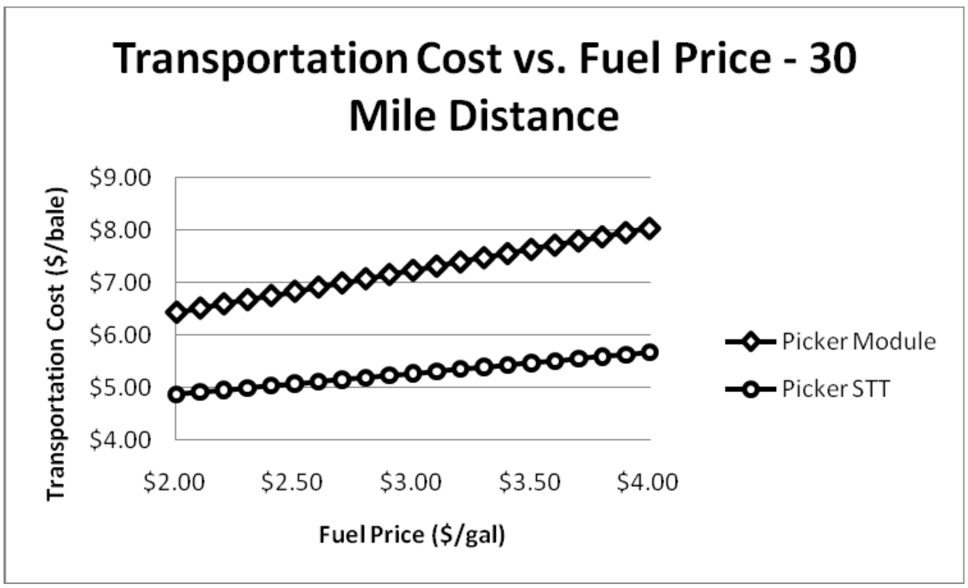

Figure 6. Transportation cost vs. fuel price at 30 miles distance.

Summary

Decision support software has been designed to aid producers and ginners in analysis of costs associated with cotton module transportation. The software is easily adaptable to custom scenarios and variables may be easily altered. The software also recognizes scenarios using semi tractor trailers to transport one and one half or two modules at a time. Due to the dimensions of both round cotton modules and square modules created by new on-board module builder designs, both transportation scenarios may be applied in conjunction with new platforms offered by Deere and Case IH. Fuel costs and their effects were analyzed and the increase in price per bale of cotton calculated for a given rise in fuel price.

Acknowledgements

The Cotton Foundation, Texas Food and Fibers Research Council – Texas Department of Agriculture, Cotton Incorporated – Texas State Support Committee, and Texas AgriLife Research provided financial support.

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