SPINDLE PICKER AND STRIPPER HARVESTING SYSTEMS COST USING COTSIM

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Abstract

COTSIM cotton harvester simulation model was used to project costs for different harvesting systems used at Hood Brothers Farm in 1999. Solid planted 38inch row, 30inch row and skip row versions were considered for spindle harvesting. Brush and finger strippers were considered for 30inch row and 10inch drill production. Seed cotton handling equipment was considered a part of each system to project an overall system cost for 750, 1,000 and 1,250 acres. A six-row harvester operating at 4.2 mph (9 ac/hr) in a solid 38 inch planting pattern with only one boll buggy and one module builder achieved the lowest harvesting costs of the spindle harvesters for solid plantings at $96.53, $80.67 and $71.60 per acre. Net returns of $516.73, $539.58 and $539.46 per acre for 750, 1000 and 1250 acres resulted with the six-row picker. Skip-row harvesting further lowered harvesting system costs and thus improved net returns with the "Jimmy Hargett" 30 inch-60 inch skip (25 ft per pass). It resulted in the lowest cost per acre and highest returns per acre of all the spindle harvesters, even though operating speed was held to 3.5 mph (9 ac/hr) because of the extra wide header. Returns peaked nearly $60.00 per acre above the two four-row harvester system at 1,000 to 1,250 acres for this system.

Runs were made using $0.57 per lb of lint for brush and finger strippers and $0.62 per lb of lint for spindle-harvested cotton. Harvesting costs were lower for the finger stripper system than the brush system. Both systems had less than half the harvesting costs of the solid planted spindle systems when a 5 mph operating speed was used. In most cases, returns for the stripper harvesters decreased with more acreage, indicating less than optimum harvesting capacity. Returns were generally greater than the returns for the solid planted, spindle harvested even at the lower lint price. Returns for 5, 6 and 8 row brush machines on 30inch rows approximately equaled the six-row solid and the "Jimmy Hargett" six-row skip-row systems.

Introduction

Farmers turn to any means available to try to reduce costs and maximize profits (or minimize losses) during tight economic times. Cotton harvesting is the largest machinery investment that is operated over the fewest acres and may be the single largest cost of production. Many Mid South growers are looking to alternatives to the spindle harvester both in ways to cover more acres and replacing spindle harvesters with lower per unit cost of brush or finger strippers. The adoption of the finger stripper is a totally different production system using 7 or 10inch drill or Ultra Narrow Row (UNR) production practices. This study was undertaken to provide a comparison of cost and returns of the different harvesting systems available for different acreages that a farmer might expect to harvest with these systems. Since different harvester configurations effectively and efficiently harvest different acreages within a given harvest season, the cost for the total complement of machinery for different acreages was investigated.

Literature Review

Nelson, et al. (1999) compared stripper harvesters with and without bur extractors to two and four row spindle pickers operating in West Texas and found small differences in harvesting costs when harvesting was restricted to a maximum of 30 days. However, when days were not restricted, the strippers were the lowest cost harvesting system. Mayfield (1998) states that the attractiveness of the stripper harvesting system is due to the initial machine cost being about half of a spindle picker, with maintenance cost that is significantly lower. He also points out that strippers, especially those equipped with a bur extractor typically do not operate as many hours per day as a spindle picker in the mid south. Gamble (1999) stated that tractor mounted strippers with trailed cotton collection and transport systems are the lowest cost way for growers to stripper harvest suggesting that the tractor mounted unit cost $82,000 and a spindle machine cost $330,000. No cost projections were made on a per acre or pound basis.

A West Tennessee producer Jimmy Hargett reported a savings of 20% of the harvesting costs associated with spindle picking six rows in an alternate 30 inch, 60 inch pattern compared to conventionally planted 38 inch rows (Reed, 2000).

This study is based on the COTSIM Cotton Harvesting Simulation Model developed by Chen, et al. (1990). COTSIM is a FORTRAN based model using Simlib simulation library. Inputs to the model include cost and performance parameters for the machinery used in the harvest system. The model utilizes a chosen weather scenario, computes days available for field work along with a yield/price curve based on weathering and time and motion data. It then simulates each machine and operation of the system. Output from the model include the time and expense associated with each operation, yield, revenues, total cost and net returns for the grower. By choosing different yield fractions and acreages, a producer can optimize the machinery needed to harvest a given acreage.

Discussion

This study identified several combinations of equipment, row patterns, plant populations and harvester types that might be used in the mid south to harvest cotton. They are listed with a brief description in Table 1. Harvester cost, fuel consumption, basket capacity and operating speed were obtained from the manufacturers and averaged for equivalent size and capacity machines with similar options. Seven hundred fifty, one thousand, and twelve hundred fifty acres of land were selected as the most likely farm size to fit larger harvesters used individually or smaller harvesters in pairs. The COTSIM model was run for three replications for each system using an average weather scenario. Module builders and boll buggies were assigned to a harvesting system based on experience of growers and previous model runs and verified to be sufficient by reviewing model output indicating the amount of time a harvester spent waiting to dump and other functions that would indicate insufficient seed cotton handling capacity. All production and harvesting systems were assumed to be equal in yield at about 875 lb lint/ac (COTSIM yield fraction of 1.2). Some systems resulted in slightly higher or lower yields due to the affect of weathering and delayed harvest.

No attempt was made to adjust the unloading times for strippers and pickers other than in the basket capacity. A comparison of basket capacity of 7500 lbs for the spindle picker and 5000 lbs for the strippers would approximate equal volumes of seed cotton but lower weights of cleaned seed cotton per basket for the strippers. Similarly, turnout was not considered between strippers and pickers but compensated for only with the lower basket capacity. Thus, the size and weight of modules of stripper harvested cotton were the same as for spindle picked cotton. The number of stripper modules was less than what would have actually occurred, favoring the cost of the strippers over the pickers. In runs simulating strippers, only a once over harvester was projected assuming 95% harvesting efficiency. Spindle picker runs were made initially assuming that 90% of the yield would be harvested in the first operation and 70% of the remaining 10% would be harvested in the second harvesting. This was a poor assumption in that few

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of the model runs showed an advantage to doing the second harvesting situation. More realistic was 80% first pick, then 70% of the remaining for a total of 94% of the crop as made in later runs.

Several runs were made to determine the effect of harvester purchase price on per acre costs for spindle harvesters (Table 2). For the 4 row spindle pickers operating in solid 38 inch planting pattern, each $10,000 additional investment resulted in $4.09, $3.36 and $2.96 greater harvest system cost for 750, 1,000 and 1,250 acres respectively. For the same harvesters each additional $10,000 investment per harvester resulted in $3.84, $3.04 and $2.58 for 750, 1,000 and 1,250 acres respectively in a skip row pattern or operating speed increase that would result in performance rate increasing from 4 to 6 acres per hour. Performance rate was computed as speed (ft/min) X width (ft) / 43,560 (ft^2/ac) X .8 (80% field efficiency) and truncated to the lower whole number. Increasing performance rate from 4 to 6 acres per hour (solid planting versus skip-row) for a typical $230,000 4 row picker would have the result of reducing harvest system cost for the 2 picker system by $12.38, $13.65 and $16.30 for 750, 1000 and 1,250 acres respectively. Net returns for the two systems showed a $13.96 greater return for the solid planting when only 750 acres were harvested; but $12.77 and $27.43 per acre greater return for the skip row system for 1,000 and 1,250 acres respectively, assuming that yield were the same for both production systems. This is a result of better utilization of the higher capacity (higher performance rate) harvesters over more acreage.

Additional runs were made looking at the speed of the harvester and performance rate on the cost and returns using 80% of the crop being harvested in the first pass. Table 4 shows a comparison of a system with two four-row spindle pickers with one boll buggy and two module builders at three levels of harvester costs and for solid and skip-row production systems. Note that second picking is an economical practice only when these two machines harvest less than 1,000 acres when picking at 80% open. Waiting until 90% of the crop is open and harvesting once over produced the highest net revenue. This was $70.87, $63.28 and $37.77 per acre greater than the twice over picking beginning at 80% open for 1,250, 1,000 and 750 acres respectively. An earlier harvest initiation date might overcome some of these differences; however, it is unlikely that $70.00 per acre would be gained. This very vividly supports many growers' practice of spending $25.00 per acre in defoliates to facilitate a once over harvest when greater than 90% of the crop is open.

The five-row 30inch spindle picker system runs indicated that more acreage should have been added to the harvesters in order to determine the optimum acreage per machine. However, the number of days to harvest (19 to 25) and the flattening of the net returns per acre would indicate that 1250 acres for the two machines should be near optimum. Thus, 625 to 750 acres per machine would be a good starting point for a producer using a 30inch solid production system. Thirty inch harvesting systems operating at 4.2 mph cost the grower $18.11, $13.07 and $8.25 per acre more for 750, 1,000 and 1,250 acres respectively, while net returns were lower than operating two four-row 38 inch machines operating at 3.5 mph on the same acres.

The six-row harvester operating at 4.2 mph (9 ac/hr) in a solid 38 inch planting pattern with only one boll buggy and one module builder achieved the lowest harvesting costs of the spindle harvesters for solid plantings at $96.53, $80.67 and $71.60 and returns of $516.73, $539.58 and $539.46 per acre for 750, 1000 and 1250 acres. Skip row harvesting further lowered harvesting system costs and thus improved net returns with the "Jimmy Hargett" 30 inch-60 inch skip (25 ft per pass) resulted in the lowest cost per acre and highest returns per acre of all the spindle harvesters using manufacturer's data, even though operating speed was held to 3.5 mph (9 ac/hr) because of the extra wide header. Returns peaked nearly $60.00 per acre above the two four-row harvester system at 1,000 to 1,250 acres for this system. These runs support the "rule of thumb" about 150 to 200 acres per row unit being the optimum acreage for spindle harvesters in the mid south.

Brush and finger stripper runs were made using $0.57 per lb for lint compared to $0.62 per lb for spindle-harvested cotton. Harvesting costs were lower for the finger system than the brush system with both less than half the harvesting costs of the solid planted spindle systems when a 5 mph operating speed was used. In most cases, returns for the stripper harvesters decreased with more acres indicating less than optimum harvesting capacity. Returns were generally greater than the returns for the solid planted, spindle harvested even at the lower lint price. Returns for a 5, 6 and 8 row brush machines on 30inch rows approximately equaled the "Jimmy Hargett" and six-row solid and six-row skip-row systems.

Growers are cautioned that differences in performance rates make big differences in harvest system costs and net returns. This occurs when the harvest window for the mid south exceeds about 22 to 25 days of actual harvesting. Weathering and yield losses add up quickly, even for an average weather scenario. If a poor weather scenario is considered, then low harvesting capacity results in big losses. Considering the past few years when above average harvesting conditions resulted in better than average yields, it is easy to see why growers often have "excess" harvesting capacity for those less than average years.

Summary and Conclusions

COTSIM harvest simulation model was run for 750, 1,000 and 1,250 acres for several spindle picker, and brush and finger-stripper harvesting systems using manufacturer's input data for price and performance. Contrasting runs for lower and higher performance rates and prices were also made. Even with a $0.05 per lb lower price for lint, the strippers were much lower in harvesting costs and higher net returns than most of the spindle harvester systems. The six-row spindle picker can reduce harvester system cost by $30.00 per acre when one machine is compared to two four-row machines on the same acres. Returns per acre are similarly increased.

Comparing costs and returns computed for this paper is only a starting point for growers considering changes in harvesting machinery. Sometimes little changes in speed, thus performance rate made large differences in costs and net returns, especially when harvest days were more than 25. If strippers are operated fewer hours per day as simulated by lower performance rates, harvesting costs approach that of spindle pickers and the penalty for stripper harvested lint may push the net returns below those of spindle harvester systems.

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Table 1. Harvester Systems Input Data for Model.

No. of Harv.	Spindle Pickers		Field Cap. (Ac/Hr.)	Basket Cap. (lb)	Harvester Price	No. Mod. Build.	No. Boll Buggy
	Rows	Configuration					
2	4	38 in. Solid	4	7500	$185,000	2	1
2	4	38 in. Solid	4	7500	$230,317	2	1
2	4	38 in. Solid	4	7500	$260,000	2	1
2	4	38 in. full skip	6	7500	$191,000	2	1
2	4	38 in. full skip	6	7500	$235,000	2	1
2	4	38 in. full skip	6	7500	$210,000	2	1
2	5	30 in. solid	5	8500	$299,662	2	1
2	5	38 in. solid	6	8500	$299,662	2	1
1	6	38 in. solid	7	8500	$325,000	1	1
1	6	38-64 skip row	10	8500	$325,000	1	1
1	6	30 in. 2X1 skip	9	8500	$325,000	1	1
		Brush Strippers					
1	5	30 in.	6	5000	$130,000	1	1
1	6	30 in.	7	5000	$135,000	1	1
1	8	30 in.	9	5000	$150,000	1	1
1	10	30 in.	14	5000	$170,000	1	1
		Finger Strippers					
1	20 ft	5 MPH Operation	9	5000	$125,000	1	1
1	20 ft	4 MPH Operation	7.5	5000	$125,000	1	1
1	20 ft	3 MPH Operation	5	5000	$125,000	1	1
1	20 ft	5 MPH Operation	9	5000	$105,000	1	1
1	20 ft	4 MPH Operation	7.5	5000	$105,000	1	1
1	20 ft	3 MPH Operation	5	5000	$105,000	1	1
1	20 ft	5 MPH Operation	9	5000	$85,000	1	1
1	20 ft	4 MPH Operation	7.5	5000	$85,000	1	1
1	20 ft	3 MPH Operation	5	5000	$85,000	1	1

Table 2. Harvester Cost and Net Returns.

Harv. Pickers	Speed MPH	Harv. Rate, Ac/Hr	Harv. Cost, $1000	Harvest Cost, $1000/Ac Acreage			Net Returns, $1000/Ac Acreage		
				750	1,000	1,250	750	1,000	1,250
2-4Row	3.5	4	185	185	185	185	185	185	185
2-4Row	3.5	4	230	230	230	230	230	230	230
2-4Row	3.5	4	260	260	260	260	260	260	260
2 Skip Row 4Row	4.2	6	191	191	191	191	191	191	191
	4.2	6	210	210	210	210	210	210	210
	4.2	6	235	235	235	235	235	235	235
	4.2	6	260	260	260	260	260	260	260
2-5Row 30 Inch	4.2	5	210	210	210	210	210	210	210
	4.2	5	293	293	293	293	293	293	293
	4.2	6	293	293	293	293	293	293	293
6Row Solid	3.5	7	300	300	300	300	300	300	300
	4.2	9	325	325	325	325	325	325	325
6Row Skip	3.5	10	325	325	325	325	325	325	325
Jimmy Hargett	3.5	9	325	325	325	325	325	325	325
Brush Stripper									
5Row 30 Inch	5	6	130	130	130	130	130	130	130
6Row 30 Inch	5	7	135	135	135	135	135	135	135
8Row 30 Inch	5	9	150	150	150	150	150	150	150
Finger Stripper	5	9	125	125	125	125	125	125	125
		7.5	125	125	125	125	125	125	125
		5	125	125	125	125	125	125	125
		9	105	105	105	105	105	105	105
		7.5	105	105	105	105	105	105	105
		5	105	105	105	105	105	105	105
		9	85	85	85	85	85	85	85
		7.5	85	85	85	85	85	85	85
		5	85	85	85	85	85	85	85

Table 3. Harvester Hours of Operation and Days to Completion.

Harv. Pickers	Speed MPH	Harv. Rate, Ac/Hr	Harv. Cost, $1000	Harvester Hours Acreage 750	1,000	1,250	Completion Days Acreage 750	1,000	1,250
2-4Row	3.5	4	185	110	143	182	19	25	32
2-4Row	3.5	4	230	110	143	182	19	25	32
2-4Row	3.5	4	260	110	143	182	19	25	32
2 Skip Row 4Row	4.2	6	191	77	102	123	12	18	22
	4.2	6	210	77	102	123	12	18	22
	4.2	6	235	77	102	121	12	18	22
	4.2	6	260	77	102	121	12	18	22
2-5Row 30 Inch	4.2	5	210	86	118	143	13	20	25
	4.2	5	293	86	118	143	13	20	25
	4.2	6	293	77	99	121	12	17	22
6Row Solid	3.5	7	300	88	118	151	13	20	26
6Row Solid	4.2	9	325	102	135	166	18	23	29
6Row Skip	3.5	10	325	126	166	205	22	29	35
Jimmy Hargett	3.5	9	325	102	135	166	18	23	29
Brush Stripper									
5Row 30 Inch	5	6	130	151	197	244	26	35	46
6Row 30 Inch	5	7	135	135	174	212	23	30	40
8Row 30 Inch	5	9	150	110	143	174	19	25	30
Finger Stripper	5	9	125	143	143	174	25	25	30
		7.5	125	142	150	205	25	26	35
		5	125	159	188	231	27	34	47
		9	105	113	150	174	20	26	30
		7.5	105	126	188	184	22	34	32
		5	105	153	202	231	27	38	47
		9	85	113	173	184	20	30	32
		7.5	85	121		231	22	-11	47
		5	85	174	202	249	30	38	55

Table 4. First and Second Pick Comparisons Using Two Four Row 38inch Spindle Pickers with One Boll Buggy and Two Module Builders.

80% Picked 1st pass, second picking						
Harvester Price			$230317.00			
Acreage	1250	1000	750	1250	1000	750
# Bad Days	9.33	8.00	6.33	42.33	40.67	16.00
# Good Days	21.67	17.00	13.00	37.33	35.00	29.50
Hours	179.27	143.15	110.33	291.40	275.60	237.80
Completion Day	42.00	36.00	30.33	90.67	86.67	56.50
Lint lbs	771.81	788.10	777.26	827.97	870.06	897.18
Total Expenses	98.61	109.34	129.57	142.81	161.49	183.88
Net Revenue	439.58	440.09	412.24	434.88	445.41	441.72
90% first picking with second picking						
Harvester Price			$230317.00			
Acreage	1250	1000	750	1250	1000	750
# Bad Days	9.67	8.00	6.33	29.67	15.67	10.67
# Good Days	22.00	17.00	13.00	34.33	29.00	23.00
Hours	181.87	142.87	110.33	272.60	232.90	189.40
Completion Day	42.67	36.00	30.33	75.00	55.67	44.67
Lint lbs	867.52	886.82	873.98	921.10	941.08	934.05
Total Expenses	99.17	109.57	129.74	147.60	159.63	175.55
Net Revenue	505.75	508.69	479.49	494.85	496.64	475.60