PICKER VERSUS STRIPPER HARVESTERS ON THE HIGH PLAINS OF TEXAS

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Abstract

Picker and stripper harvest systems were compared for harvesting irrigated cotton on the High Plains. Four varieties of cotton were harvested using a six-row picker harvester and a six-row stripper harvester with and without field cleaning. A net present value analysis was conducted comparing each harvest system. Inputs for time in motion and fiber quality were determined based on field data from the 2006 and 2007 harvest seasons.

Introduction

Over a fourth of the cotton bales produced in the United States since 2002 have been produced in Texas (USDA, 2008b) with most of that cotton coming from the High Plains region. Five of the eight distinct cotton producing regions in Texas, including the High Plains, Rolling Plains, Central Blackland, Coastal Bend, and Winter Garden regions, are primarily harvested using stripper harvesters, while the Upper Gulf Coast, Rio Grande Valley, and El Paso/Trans-Pecos regions primarily use picker harvesters (Nelson et al., 2001). Approximately 85 percent of the cotton produced in Texas is currently stripper harvested (Glade et al., 1996).

Unlike picker harvesters, which use spindles to remove seed cotton from the boll of the plant, stripper harvesters use brushes and bats that indiscriminately remove seed cotton, bolls, leaves, and many branches from the stem of the plant. As a result, stripper harvested cotton contains more foreign matter than spindle picked cotton. This increased foreign matter leads to higher transportation costs per bale to haul modules to the gin as well as potentially higher costs of processing the cotton, due to the use of additional cleaning machinery at the gin. Foreign matter may be reduced by the use of a field cleaner (often called a burr extractor), but foreign matter levels are still greater than found in spindle picked cotton.

Stripper harvesters do have several advantages over picker harvesters, including lower purchase prices, fewer moving parts in the row units, lower fuel consumption and maintenance requirements, and faster ground speeds in low yielding cotton. Picker harvesters, however, pick cleaner cotton, are perceived to maintain fiber quality characteristics better than strippers, and are able to harvest cotton at higher speeds in high yielding stands.

As irrigation technology has improved and new cotton varieties have been introduced and adopted on the High Plains, yields in the region have dramatically increased, sometimes reaching four to five bales per acre. It is estimated that between 300,000 and 400,000 acres of drip irrigation has been installed on the High Plains in the past ten years for cotton production, and over 1.1 million acres are irrigated with center pivot systems equipped with high efficiency application packages. Furthermore, foreign textile mills continue to raise their standards for fiber quality as cotton spinners are forced to compete with synthetic fibers that are not plagued with fiber contamination and degradation. These increased yields and higher quality demands have the potential to make harvesting High Plains cotton with pickers an attractive option.

Several economic analyses have been suggested to evaluate different cotton harvest systems. Vories and Bonner (1995) compared gross returns per acre from picked and stripped cotton and found that on average, the stripper had greater return per acre. However, this study was conducted on cotton yielding less than two bales per acre and may not be reflective of returns in higher yielding cotton. Vories and Bonner (1995) also made no attempt to analyze differences in operational costs between systems but compared returns based on lint value only. Faircloth et al. (2004) found similar results in northeast Louisiana, but their comparison suffered from similar deficiencies.

Nelson et al. (2001) compared alternative stripper and picker harvesting systems and included operational and maintenance costs for each system along with the cost of custom harvesting as an alternative to equipment ownership. The analysis by Nelson et al. (2001) includes many important considerations and may serve as a model for further comparisons, but Nelson et al. (2001) compared only different stripper systems with other stripper systems and picker systems with other picker systems. No comparison was made between picker and stripper based harvest systems. Spurlock et al. (2006) conducted a similarly robust economic analysis comparing different row configurations for picker harvesters, but again, no comparison was made between picker and stripper systems.

Yates et al. (2007) proposed results for an economic study comparing picker and stripper harvesters, but he extrapolated the fiber quality results from an older two-row model picker to a new six-row picker and from an older four-row stripper to a new eight-row picker. Yates et al. (2007) states that "performance rates" were used in the model, but no discussion is given regarding the information included in those "performance rates." Yates et al. (2007) described the economic model used as the Cotton Economics Research Institute Cotton Harvesting Cost Calculator, but gave no details of the model. Given the lack of information and the unscrupulous extrapolation, the results of Yates et al. (2007) should not be considered as a viable economic model.

Willcutt et al. (2001) described the most comprehensive economic model for comparing harvest systems using the COTSIM cotton harvester simulation model developed by Chen et al. (1992). Willcutt et al. (2001) simulated various harvesters on various size farms with different row configurations (e.g. skip-row, solid rows, etc.), but all production systems were assumed to yield 875 pounds of lint per acre (1.8 bales per acre). Willcutt et al. (2001) found that, even with a five cent per pound reduction in price for lint, stripper systems yielded higher net returns than picker systems. However, Willcutt et al. (2001) assumed similar basket volumes for both machines, assumed that strippers could operate the same number of hours per day as pickers, and that the same number of modules would be produced from both systems. All of these assumptions are erroneous and may significantly affect harvest system economics. Willcutt et al. (2001) concluded, however, that if strippers were operated fewer hours per day than pickers and the number of harvest days available was limited, returns from stripper systems quickly fell to or below the level of returns from picker harvesters. Furthermore, Willcutt et al. (2001) did not account for slower stripper speeds that will result from higher yielding stands, which also favor picker harvester systems.

While each of the aforementioned studies yields insight into the decision matrix needed to determine the best harvest system for irrigated cotton on the High Plains, none of these studies addresses the issue holistically. A net present value analysis was conducted to compare the economic returns for picker and stripper harvesters on the High Plains of Texas. Model inputs regarding harvester performance and cotton fiber quality from each system were determined from field measurements taken during harvest of four varieties of cotton in 2006 and 2007.

Materials and Methods

A net present value analysis was conducted to compare the economic returns to be expected from six-row picker and stripper harvesters. NPV for each system was calculated as (Bowlin et al., 1990):

$$NPV = \sum_{t=0}^{n} \frac{C_t}{(1+k)^t} \tag{1}$$

where: NPV = net present value ($),
n = duration of the investment,
C_t = net cash flow at time period t, and
k = discount rate.

For a given area harvested per machine, the yield required for the NPV of a picker system to equal the NPV of a stripper system with a field cleaner and a stripper system bypassing a field cleaner were calculated.

Base Scenario

In the base scenario, the investment cost was determined assuming that each machine was purchased with 100% liability and the purchase was amortized into equal payments over seven years, assuming the salvage value as the future value. The real interest rate (4.8%) was assumed as the discount rate (eq. 2; Bowlin et al., 1990) and was calculated using the average 2007 intermediate agricultural lending rate (9.28%; Federal Reserve Bank of Dallas, 2008) adjusted by the farm machinery inflation rate (4.3%; USDA-NASS, 2008a).

$$k = \frac{(1+NR)}{(1+IR)} - 1 \tag{2}$$

where: k = real discount rate,
NR = nominal rate (here, intermediate agricultural lending rate), and
IR = inflation rate (here, intermediate agricultural lending rate).

The cost of each machine was calculated assuming a purchase price of 90% of the MSRP (Spurlock et al., 2006) and a salvage value equal to 45% of the purchase price (Nelson et al., 2001). Taxes, housing, and insurance were calculated as 2% of the purchase price per year (ASAE Standards, 2006).

Harvester operation parameters and turnout were estimated based on field measurements from the 2006 and 2007 harvest seasons (table 1).

Table 1. Harvester parameter inputs measured during 2006 and 2007 harvest seasons.

	Picker	**Stripper with Field Cleaner**	**Stripper without Field Cleaner**
Speed (kph [mph])	6.1 (3.8)	5.5 (3.4)	5.5 (3.4)
Basket Capacity (bales)	4.8	2.1	1.8
Dump Time (s)	76	45	45
Lint Turnout (%)	35	30	27
Seed Turnout (%)	55	46	40

A row spacing of 76 cm (30 in.) was assumed. Harvester fuel use was estimated at 26.2 and 13.1 L/ha (2.8 and 1.4 gal/ac) for the picker and stripper, respectively, and a spot diesel price of $0.86/L ($3.25/gal) was assumed. A single application of harvest aid was assumed for picked cotton at $25/ha ($10/ac), whereas a second harvest aid application (at an additional cost of $25/ha) was assumed for stripped cotton. Labor costs were a function of the time required to harvest a given area based on measured time-in-motion data, and a labor rate of $5.85/hr was assumed. Ginning was assumed to cost $0.58/kg ($2.65/cwt) with no bagging and tie charges and no module transportation costs. A seed price of $0.18/kg ($160/ton) was also assumed. The value of cotton from each harvest treatment was determined by averaging the West Texas spot price for cotton from each harvest treatment from 2006 and 2007.

Input Variability

A sensitivity analysis was conducted to determine the effect of changes in the input parameters on the breakeven yield for a given harvested area. Sensitivity was calculated as:

$$S = \left| \frac{\Delta Y}{\Delta I} \right| \tag{3}$$

where: S = model sensitivity, and
ΔY = change in breakeven yield per unit change in input parameter I.

The ranges of values for each input parameter to determine a "confidence interval" for breakeven lines are shown in table 2.

Table 2. Ranges of values for NPV model input parameters.

Model Input	Base Scenario			Range
	Picker	Stripper w/FC	Stripper w/o FC	
Farm				
Row Spacing (cm [in])	76 (30)	76 (30)	76 (30)	76-101 (30-40)
Row Length (m [ft])	915 (3000)	915 (3000)	915 (3000)	±15%
Harvester				
Loan Life (yrs)	7	7	7	None
Loan Rate (% APR)	4.3%	4.3%	4.3%	±2%
Salvage Value (% PP)[a]	45%	45%	45%	±5%
T,H,I (% PP)[a,b]	2%	2%	2%	±0.5%
MSRP ($)	$431,174	$187,303	$169,303[c]	None
Purchase Price (% MSRP)	90%	90%	90%	±5%
Operating Costs				
Diesel ($/gal)	$3.25	$3.25	$3.25	±15%
Labor ($/hr)	$5.85	$5.85	$5.85	±10%
Harvest Aid Applications	1	2	2	None
Harvest Aid Price ($/ap/ha)	$24.70	$24.70	$24.70	±20%
End Row Time (s)	20	20	20	±25%
Speed (kph [mph])	6.1 (3.8)	5.5 (3.4)	5.5 (3.4)	±10%
Fuel Use (L/ha [gal/ac])	26.2 (2.8)	13.1 (1.4)	13.1 (1.4)	±20%
Basket Cap. (kg SC [lbs])[c]	3175 (7000)	1590 (3500)	1520 (3350)	±15%
Dump Time (s)	76	45	45	±25%
Ginning				
Ginning ($/kg SC [$/cwt])[d]	$0.58 ($2.65)	$0.58 ($2.65)	$0.58 ($2.65)	±15%
Lint Turnout (%)	35%	30%	27%	±3%
Seed Turnout (%)	55%	46%	40%	±3%
Lint Price ($/kg [$/cwt])	$1.1758 ($53.38)	$1.1458 ($52.02)	$1.0868 ($49.34)	None
Seed Price ($/kg [$/ton])	$0.18 ($160)	$0.18 ($160)	$0.18 ($160)	±20%

[a] PP = purchase price
[b] T,H,I = taxes, housing, and insurance (taxes = 1%; housing = 0.75%; insurance = 0.25%)
[c] Currently, stripper harvesters are not commercially available without field cleaners
[d] SC = seed cotton

Results and Discussion

Under the conditions analyzed, the NPV of the stripper system without a field cleaner was always lower than the stripper system with a field cleaner, indicating that stripping without field cleaning is never the most profitable option. However, this analysis does not take into account the risk averted by stripping without field cleaning on days that are too windy to transfer picked or field-cleaned seed cotton from the harvester basket to a boll buggy or module builder. The model also does not place a monetary value on the reduced risk incurred by being able to pick a field earlier than a producer can strip a field or the increased risk incurred through the additional capital investment cost of a picker.

The breakeven yield for a given harvested area decreases as row spacing increases. For example, the breakeven yield between picking and stripping-with-field-cleaning when harvesting 320 ha (800 ac) per machine per year is 5.75 bales/ha (2.33 bales/ac) with the base scenario inputs on 76 cm (30 in.) rows, but it decreases to 5.56 bales/ha (2.25 bales/ac) when on 102 cm (40 in.) rows, assuming the same yield of lint per acre.

The breakeven curve between picking and stripping with a field cleaner is shown in fig. 1. The breakeven curve between picking and stripping without a field cleaner is shown in fig. 2. The black line in both figures represents the breakeven curve for the base scenario while the shaded area represents possible breakeven points within the range of input variables shown in table 2. Areas above the breakeven line represent scenarios in which more profit may be obtained from picking while areas below the breakeven line represent scenarios in which more profit may be obtained by stripper harvesting. Table 3 shows the relative returns per unit area for the picker and stripper-with-field-cleaner systems relative to stripping without field cleaning assuming one machine is used to harvest 243 and 486 ha (600 and 1200 ac), respectively, under the base scenario.

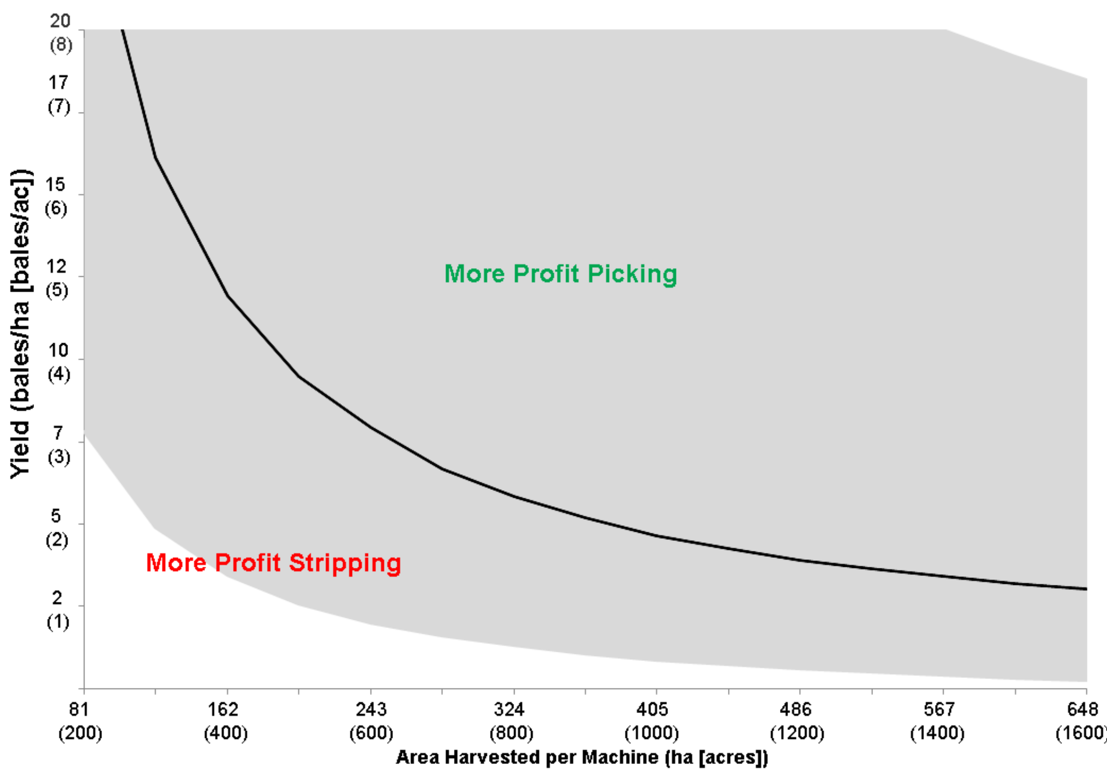

Figure 1. Breakeven curve between picking and stripping with field cleaner from NPV analysis.

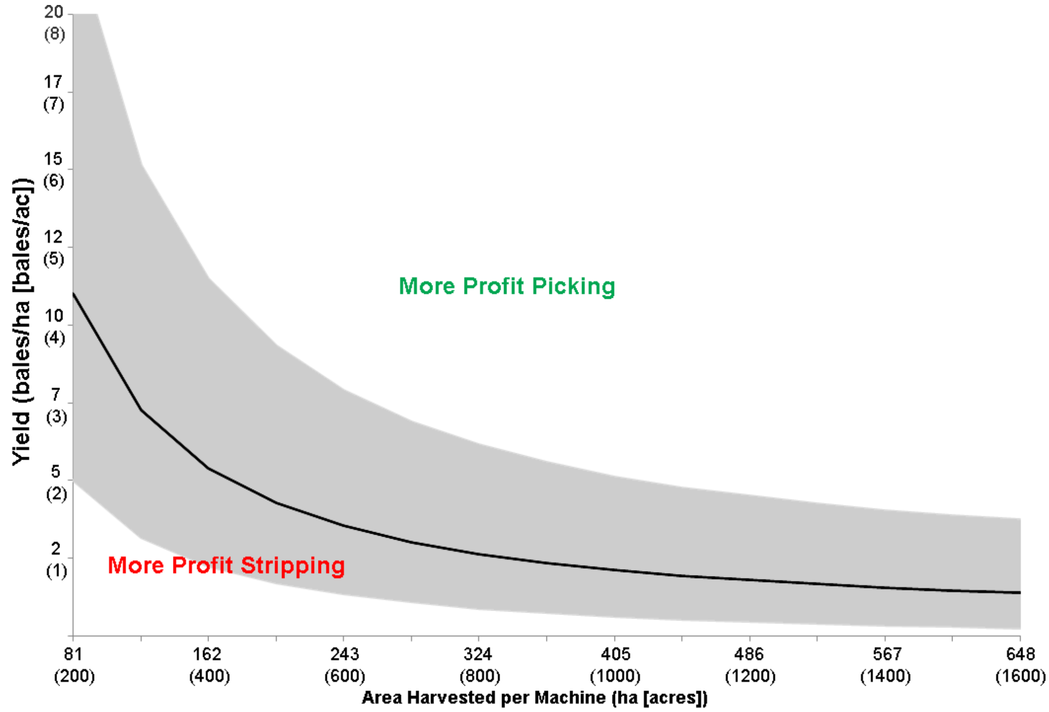

Figure 2. Breakeven curve between picking and stripping without a field cleaner from NPV analysis.

Table 3. Relative returns ($/ha [$/ac]) for various harvest systems.[a]

Yield	Picker	Stripper w/ Field Cleaner	Stripper w/o Field Cleaner
243 ha (600 ac) per Machine			
3.7 (1.5)	$22 ($9)	$393 ($159)	Base
4.9 (2.0)	$281 ($114)	$544 ($220)	Base
6.2 (2.5)	$539 ($218)	$694 ($281)	Base
7.4 (3.0)	$798 ($323)	$845 ($342)	Base
8.7 (3.5)	$1,057 ($428)	$996 ($403)	Base
9.9 (4.0)	$1,316 ($533)	$1,146 ($464)	Base
11.1 (4.5)	$1,575 ($637)	$1,297 ($525)	Base
12.4 (5.0)	$1,834 ($742)	$1,448 ($586)	Base
486 ha (1200 ac) per Machine			
3.7 (1.5)	$396 ($160)	$418 ($169)	Base
4.9 (2.0)	$655 ($265)	$569 ($230)	Base
6.2 (2.5)	$914 ($370)	$719 ($291)	Base
7.4 (3.0)	$1,173 ($475)	$870 ($352)	Base
8.7 (3.5)	$1,432 ($579)	$1,021 ($413)	Base
9.9 (4.0)	$1,690 ($684)	$1,171 ($474)	Base
11.1 (4.5)	$1,949 ($789)	$1,322 ($535)	Base
12.4 (5.0)	$2,208 ($894)	$1,473 ($596)	Base

[a] Assuming the stripper without field cleaner as a base value and with inputs from the Base Scenario.

From figs. 1 and 2, it can be seen that the breakeven yield decreases as the area harvested per machine increases. Furthermore, the yields required for picking to be more profitable than stripping are achievable on the High Plains if a producer has sufficient area to harvest per machine.

The sensitivity of the NPV model to input parameters is shown in table 4 along with the scenarios that would lead to the highest and lowest breakeven yields per unit area. Sensitivity to input variables that differed between stripper and picker treatments was described by the average sensitivity value as calculated by eq. 3.

Table 4. Sensitivity of NPV model to input parameters.

Rank	Model Input	Sensitivity	Max. Breakeven Yield		Min. Breakeven Yield	
1	Diff. Lint Price[a]	7.50	Min. Pick.	Max. Strip.	Max. Pick.	Min. Strip.
2	Seed Turnout	1.71	Min. Pick.	Max. Strip.	Max. Pick.	Min. Strip.
3	Purchase Price	1.35	Max. Pick.	Min. Strip.	Min. Pick.	Max. Strip.
4	Lint Turnout	0.59	Max. Pick.	Min. Strip.	Min. Pick.	Max. Strip.
5	Salvage Value	0.47	Minimize		Maximize	
6	Ginning	0.30	Minimize		Maximize	
7	Loan Rate	0.26	Maximize		Minimize	
8	Speed	0.23	Min. Pick.	Max. Strip.	Max. Pick.	Min. Strip.
9	Harvest Aid Price	0.23	Minimize		Maximize	
10	Fuel Use	0.13	Max. Pick.	Min. Strip.	Min. Pick.	Max. Strip.
11	Row Spacing	0.10	Minimize		Maximize	
12	Diesel	0.09	Maximize		Minimize	
13	Seed Price	0.08	Minimize		Maximize	
14	T,H,I[b]	0.05	Maximize		Minimize	
15	Labor	0.01	Minimize		Maximize	
16	Basket Capacity	0.00	Min. Pick.	Max. Strip.	Max. Pick.	Min. Strip.
17	Dump Time	0.00	Max. Pick.	Min. Strip.	Min. Pick.	Max. Strip.
18	Lint Price	0.00	No effect		No effect	
19	End Row Time	0.00	No effect		No effect	
20	Row Length	0.00	No effect		No effect	

[a] Diff. Lint Price = difference in price between lint harvested with various harvest methods
[b] T,H,I = taxes, housing, and insurance

The NPV model is over four times more sensitive to difference in the price of lint between harvester treatments than any other input parameter. However, the model is relatively insensitive to changes in the price of lint if the price of both picked and stripped lint increase by the same amount. The difference in price between picked and stripped lint is likely to be most influenced by growing conditions (which affect the difference in lint grades) rather than harvest method. The growing conditions in 2007 resulted in high fiber maturity values, which is uncommon. In less ideal years, the difference in grade between picked and stripped cotton is expected to be greater (see 2006 data and Kerby et al., 1986) thus reducing the breakeven yield for a given harvested area.

Seed turnout and harvester purchase price, which are the second and third most influential model inputs, are substantially impacted by harvest method. The model is relatively insensitive to changes in harvester basket capacity, dump time, the time spent on the turn row, and row length within the ranges analyzed.

Conclusions

A breakeven analysis based on NPV was conducted to compare picker-based and stripper-based harvest systems with and without field cleaners. Under no conditions analyzed was the NPV of a stripper system without a field cleaner greater than a stripper system with a field cleaner. Breakeven curves relating yield to harvested-area-per-machine were developed to compare picker-based systems with both stripper-based systems. The breakeven yield decreases as the area harvested per machine increases. Furthermore, the yields required for picking to be more profitable than stripping are achievable on the High Plains if a producer has sufficient area to harvest per machine.

The results of a sensitivity analysis of the NPV model demonstrate that the model is most sensitive to changes in the difference between picked and stripped lint, which is most influenced by growing conditions rather than harvest method. The model is relatively insensitive to level changes in the price of lint. The model is relatively sensitive to changes in seed turnout and machinery purchase price. It is expected that the breakeven yield for a given harvested area will decrease with more adverse growing conditions (leading to less mature fibers) and increase with more ideal growing conditions (leading to more mature fibers).

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