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Nonirrigated Spindle Picker 15-Inch and Wide-Row

Cotton Production Systems Analysis

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Abstract

A 2-year (2004-2005) study at Clarksdale, Mississippi, and 4-year (2003-2006) studies at Verona, Mississippi, and Falkner, Mississippi, evaluated the effects of spindle picker narrow-row and wide-row patterns on cotton yield, cotton maturity, plant stem diameter, and plant height at harvest, as well as fiber quality and whole-farm net revenue. The studies included several row patterns: (1) 15-, 30-, and 38-inch row solid; (2) 15-inch, 2x1 skip-row pattern (two rows with a 30-inch skip); (3) 15-inch, 2x2 skip-row pattern (two rows with a 45-inch skip); (3) 30-inch, 1x1 skip-row pattern (60-inch rows); (4) 30-inch, 2x1 skip-row pattern (two rows with a 60-inch skip); and (5) 38-inch, 2x1 skip-row pattern (two rows with a 76-inch skip). Seeding rates were four seeds per foot of row for all 38-inch rows and three seeds per foot of row for all 30- and 15-inch row patterns.

The 15-inch, solid-row plant height at harvest averaged 2–6 inches shorter than wide rows, and the average plant stem diameters at harvest were up to 0.10 inch smaller. Rotten boll numbers at harvest were very low at all locations with only minor differences among row patterns. Maturity, based on the percent of open bolls at defoliation, indicated no differences among the 15-, 30-, and 38-inch solid-row patterns. The 2-year average lint yield at Clarksdale was 1,195 pounds per acre with no differences among the 15-, 30-, and 38-inch solid-row patterns. Four-year average lint yield in the 15-inch solid pattern at Verona (1,047 pounds per acre) and Falkner (1,278 pounds per acre) was 2% and 7% higher than in the 30- and 38-inch solid-row patterns. Yields in the 15-inch, 2x2 skip-row pattern at Verona were 91% of yields in the 15-inch, solid-row patterns; at Falkner, 92%; and at Clarksdale, 94%. Averaged over locations and years, the 15-inch, 2x2 skip-row pattern yield was 4% higher than the 30-inch, 2x1 skip-row pattern; 11% higher than the 38-inch, 2x1 skip-row pattern; and 14% higher than the 30-inch, 1x1 skip pattern (60-inch solid rows). The 15-inch, 2x1 skip-row pattern yield was equal to 15-inch solid rows at Verona and 97% of the 15-inch solid rows at Clarksdale and Falkner. Averaged over locations and years, the 15-inch, 2x1 skip-row pattern yield was 10% higher than the 30-inch, 2x1 skip-row pattern; 18% higher than the 38-inch, 2x1 skip-row pattern; and 21% higher than the 30-inch, 1x1 skip-row pattern (60-inch rows). Row patterns showed only minor differences in HVI and AFIS fiber properties. Environment had a greater impact on HVI and AFIS fiber properties than row patterns.

The hypothetical whole-farm revenue analysis — using the maximum acreage per cotton harvester for each row pattern — indicated that both 30-inch and 15-inch solid rows had the smallest harvest swath widths and lowest total farm cotton acreages. This factor resulted in the 30- and 15-inch solid rows having the highest machinery ownership cost per acre and the lowest whole-farm net revenue at all locations. The 15-inch, 2x2 skip-row pattern at Verona and Falkner, as well as the 38-inch solid at Clarksdale, produced the highest whole-farm net revenue.

Nonirrigated Spindle Picker 15-Inch and Wide-Row Cotton Production Systems Analysis

Introduction

Efficient cotton production and improved net returns are essential for Mississippi cotton growers to maintain a competitive advantage in a global economy. Ultra-narrow-row (UNR) stripper cotton and skip-row cotton production systems have been used as means for improving profitability. UNR cotton (Atwell 1996; Buehring et al. 2001; Nichols and Snipes 2002; Shurley et al. 2002) has yields and net returns (Parvin et al. 2002; Shirley et al. 2002) at least as large as conventional wide rows. However, several factors have offset these advantages: negative spinning quality, inability to operate finger strippers under damp conditions, and increased trash content. Increased trash content in the material taken to the gin reduces gin-processing capacity (Brashears 1968; Mayfield 1999; and Anthony et al. 1999, 2000). HVI fiber quality analysis showed no differences in cotton harvested by spindle picker, brush stripper, and finger stripper from 10-inch rows (Anthony et al. 1999, 2000; Willcutt et al. 2001). However, their reports indicated the finger stripper samples had increased neps per gram (spinning flaws in making fabric). Therefore, stripper-harvested UNR cotton is most often discounted 3–5 cents per pound of lint, plus any reductions for bark, trash, or gin processing (Willcutt et al. 2001). Reports also indicated that skip-row cotton improves profitability, especially when cotton prices are low (Hargett 2000; Parvin et al. 2000, 2002; Jost et al. 2003; Fromme et al. 2004). The improved profitability is associated with savings of seed and "down-the-row" production input cost, such as seed, technology fees, chemical costs, and fixed costs due to increased harvesting capacity (harvest more acres with same machine). However, seldom have economic return analyses in these reports been based on actual field side-by-side comparisons for lint yield, gin turnout, and lint value per acre based on HVI fiber analysis.

Deere and Company's introduction of the 15-inch-row John Deere PRO 12 Vari-Row System (VRS) spindle-picker units makes possible spindle-picker production systems that not only approximate UNR stripper-cotton systems, but also have the potential to maximize fiber spinning quality (lower neps and trash than stripper-harvested lint) while retaining the operational benefits of a spindle picker. This system also allows for possible 15-inch, skip-row combinations to reduce boll rot potential that can occur with UNR cotton in the rain belt.

Recent research reports indicated the 15-inch, solid-row pattern had greater lint yields than 30-inch or 38-inch rows (Buehring et al. 2004, 2005, 2006; Willcutt et al. 2004, 2005, 2006; Wilson et al. 2005, 2007; Stephenson et al. 2007; Reddy et al. 2007). However, others (Harrison et al. 2006; Balkcom et al. 2007; Gwathamey and Steckel 2007) reported that lint yields in the 15-inch skip-row pattern and 15-inch solid pattern were equivalent to 30- or 38-inch rows. A hypothetical whole-farm cost and return analysis reported by Spurlock et al. (2006), using 2005 input prices, indicated the 15-inch, 2x2 skip-row pattern for the Mississippi Hill area allowed greater acreages to be farmed and showed higher net revenue than 15-inch solid cotton. The 30-inch, 2x1 skip-row pattern showed higher whole-farm net returns than 15-inch solid; this pattern showed net returns only slightly higher than the 38-inch row for the Delta area.

The objective of this study was to determine the effect narrow- and wide-row cotton spindle-picker production systems have on end-season plant characteristics, lint yield in nonirrigated environments, and whole-farm net revenues based on 2006 input prices, field plot seed cotton yield, gin turnout, lint yield, and fiber quality.

Materials and Methods

Eight row patterns (Figure 1) were evaluated at three locations. Studies were conducted from 2003–2006 on a Marietta silt loam and Falaya sandy loam soil at Verona and Falkner, Mississippi, respectively. A study also was conducted in 2004 and 2005 on a Dubbs very fine sandy loam soil at Clarksdale, Mississippi. Studies at all locations were conducted with a split-plot experimental design with row pattern as main plot and years as subplot. Four replications were used at all locations, and the plot size was 20 feet by 120 feet. Deltapine 449BG/RR cotton was planted no-till into a spring-prepared stale seedbed in early to late May 2003–2006 at Falkner and Verona and late April to early May 2004–2005 at Clarksdale.

Currently recommended agronomic production practices were used at all locations. Seeding rates at all locations were three seeds per foot of row for all 15- and 30-inch rows and four seeds per foot of row for 38-inch rows. All cotton plots were harvested in 2003 and 2004 with a John Deere PRO-12 VRS picker unit (equipped with a twin-row, 15-inch-spacing spindle picker head modification) mounted on a single-row picker using a John Deere 4020 as the power unit. In 2005 and 2006, the plots were harvested with a John Deere 9960 picker equipped with two John Deere PRO 12 VRS picker units that were adjustable for each row pattern. Various numbers of rows from each plot were harvested for yield: (1) 15-inch solid — four or eight rows; (2) 15-inch, 2x1 skip-row pattern — four rows; (3) 15-inch, 2x2 skip-row pattern — four rows; (4) 60-, 30-, and 38-inch solid row — two rows; and (4) 30- and 38-inch, 2x1 skip-row pattern — two rows. None of the border rows in each plot were harvested for yield.

Seed cotton from the harvested plots was ginned with a mini-gin (state-of-the-art cotton gin, equivalent to a commercial gin) to determine lint yield. Lint moisture determinations were made on all samples after ginning. The lint yield was calculated on a land area basis and adjusted to 6% moisture for all plots before data analysis. Data collected at all locations included plant height at harvest, plant population at harvest, plant stem diameter at harvest, and lint yield. Percent open bolls at defoliation and rotten bolls at harvest were collected at Clarksdale and Falkner. Cotton Incorporated examined lint subsamples to describe the fiber properties using HVI and AFIS analysis. The net loan price for each treatment was calculated based on the 2005 USDA Commodity Credit Corporation base loan rate of $0.52 per pound with premiums and discounts based on each year's plot HVI fiber quality data.

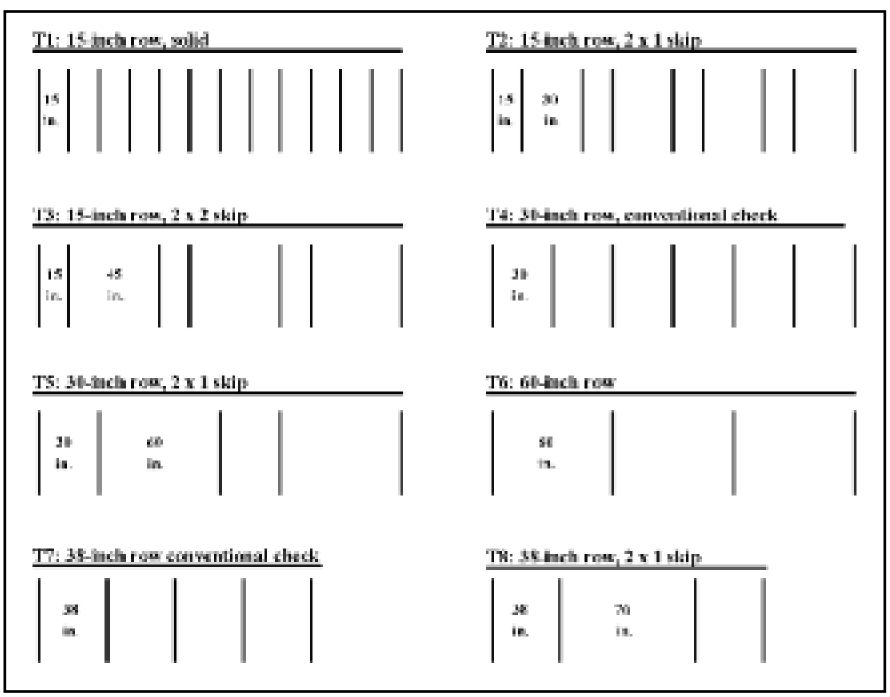

Figure 1. Row patterns evaluated.

The United States Department of Agriculture (USDA) – Agricultural Marketing Service's Agricultural Handbook 566 *The Classification of Cotton* was used as a guide to interpret the HVI fiber analysis data. The *Uster® AFIS PRO — What Does the Data Mean? Common Test Results in Upland Cotton* (Uster, February 2004) publication was used as a guide in interpreting AFIS fiber analysis data.

Whole-Farm Analysis

In the hypothetical cotton farm enterprise, crop budgets for each treatment and location were developed based on Mississippi 2006 prices (2007 Cotton Planning Budgets, Mississippi State University, Department of

Agriculture Economics, Budget Report 2006-01) and the inputs used at each location with some modifications. Budgets for all row patterns — except the 15-inch solid — included postdirect layby equipment, herbicide, and application costs. The 15-inch row budgets used only postemergence over-top broadleaf and grass herbicides. Table 1 provides details of methods used in determining net revenue for the hypothetical farms.

The hypothetical scenarios assumed that a John Deere Model 9996 cotton picker was configured to accommodate each row pattern. Three row patterns had 15-inch rows: 15-inch solid; 15-inch, 2x1 skip rows; and 15-inch, 2x2 skip rows. These patterns required the use of the John Deere PRO 12 VRS picking units. However, the 15-inch rows with skips required some modifications because the marketed picker is not designed to accommodate skipped rows. Therefore, the relevant scenarios assumed that the picker could be converted to accommodate one or two skipped rows at an extra cost. The other five row patterns had more conventional row spacings and skips, thus these scenarios assumed the use of John Deere PRO 16 picking units.

As the effective harvest swath width of a picker increased to accommodate the wider row width or the skipped rows, its harvest capacity (acres per hour) increased, allowing it to cover more acres in the same amount of time. The hypothetical scenarios assumed that each picker traveled at 3.6 miles per hour, had a field efficiency of 70%, and operated for 200 hours during the harvest season. Therefore, the amount of land per picker was adjusted to maintain the maximum picker harvest capacity for each row pattern.

Picker information for the eight row pattern treatments at the two hypothetical farms in the Hill area (Verona and Falkner) of Mississippi is listed in Table 2. In this region, four-row-unit pickers are more common. Scenarios assumed these farms would own two pickers. The estimated purchase price was 90% of the 2005 manufacturer suggested retail price (MSRP). Figure 2 shows the configuration of the picking units that would be needed to accommodate the eight row pattern treatments. The skip-row patterns enhance the field harvest capacity of the picker when compared with the solid-row patterns. The 60-inch solid (treatment 6) and the 15-inch, 2x2 skip-row (treatment 3) patterns had the widest harvest swath (20 feet) and thus the largest acreage per picker and total farmed acreage.

The hypothetical Delta farm (Clarksdale) owned three pickers, each with six picking units. Because existing six-

Table 1. Description of methods used in the hypothetical farm analysis.

I. Cost Definition

A. Operating cost:

(1) Inputs, services, repair, and labor associated with machinery operation and maintenance, as well as interest on these inputs.

(2) Total specified operating costs did not include management, consultant fees, or farm overhead cost.

(3) Operating costs were based on actual production practices used on the study sites with modifications for skip-row and wide-row systems. A postdirect herbicide application was used for the wide- and skip-row budgets. Postemergence over-top herbicides were used for 15-inch solid cotton.

(4) Nitrogen as ammonium nitrate was used for Verona and Falkner budgets. Urea-ammonium nitrate solution (UAN) preplant plus urea was used for Clarksdale location budget. The skip-row pattern N rates were 90% of solid-row cotton.

B. Ownership cost:
Manufacturer's suggested retail price (less 10%) was amortized to compute the annualized capital replacement value for equipment at the end of its useful life (8 years useful life for pickers and tractors).

C. Gross Revenue:
Net loan price x lint yield based on gin turnout (MSU-mini gin; equivalent to a commercial gin) plus cottonseed sale: 1.55 x lint yield x 4.7 cents per pound ($94 per ton).

D. Land rent charge:
Hills = $55 per acre; Delta = $85 per acre (2005 Ag. Econ. survey).

II. 2006 Prices for MSU Budget Generator (based on statewide 2006 average prices)

A. Diesel fuel: $2.41 per gallon.

B. Tech fee (Seed cost): Round-up Ready/BT program for the Deltapine DP449BG/RR variety was used in the study. Seed cost was $0.40 per thousand plus technology fee of $0.93 per thousand seed with a cap at $49 per acre.

C. Cotton Lint price: 2006 USDA's Commodity Credit Corporation base loan rate of $0.52 per pound with adjustments for HVI fiber quality for the Clarksdale, Verona, and Falkner locations.

III. Picker Performances and Cotton Row Pattern Farm Acreages

A. Acres per hour of use = swath width x rate of travel (3.6 mph) x efficiency (0.7) ÷ 8.25

B. Acres per picker = acres per hour x 200 hours per season.

C. Acres per farm row pattern system = number of pickers x acres per picker.

(1) Hill Farm: two four-row pickers at 611 acres per picker in 15- and 30-inch solid.

(2) Delta Farm: three six-row pickers at 914 acres per picker for 15- and 30-inch solid and three four-row pickers at about 1,200 acres per picker for 15-inch, 2x2 skip; 38-inch 2x1 skip; and 60-inch rows.

D. One Boll Buggy and two tractors per picker for all locations.
One module builder per picker was used for Verona and Falkner, and two module builders for all three pickers were used for Clarksdale.

E. All row pattern systems per location had the same number of tractors, pickers, and boll buggies. The Hill farms had four tractors, and the Delta farm had six tractors.

row-unit cotton pickers are not designed to accommodate the larger swath widths required for treatments 3, 6, and 8, these treatments used four-row-unit pickers. Table 3 shows the estimated picker cost, picker harvest swath width, acres per picker, and total acres for the hypothetical Delta farm. The estimated picker purchase price was 90% of 2005 MSRP. The 15-inch, 2x1 skip-row pattern and the 30-inch, 2x1 skip-row pattern had the largest harvest swath of all treatments, and thus had the most acreage per picker and highest total farm acreage.

Figure 3 shows the configuration of the picker units that would accommodate the 12-row-pattern production systems for the Delta farm. The skip-row patterns show the increased harvest swath width of the picker, which increased the farm acreage per picker. The 15-inch, 2x1 skip-row pattern and the 30-inch, 2x1 skip-row pattern had the largest harvest swath width and total farm acreage. Planters and other implements were selected to accommodate the treatment row patterns. The hypothetical smaller farms in the Hill area owned four tractors, while the hypothetical larger farms in the Delta area owned six tractors.

Revenue for the whole-farm cotton enterprise was based on the production of lint and cottonseed. Lint yields for the 2003–2006 field experiments at the North Mississippi Research and Extension Center in Verona and an on-farm study at Falkner, as well as the 2004–2005 farm study at Clarksdale, were used to cal-

Table 2. JD 9996 Picker with four-row-unit cotton picker information for the farms in the Hill area (Verona and Falkner).

Row pattern treatment	Estimated purchase price[1]	Swath width	Acres per picker	Acres per farm
	$	*ft*		
15-inch solid	310,266	10.00	611	1,222
15-inch 2x1 skip	344,187	15.00	916	1,833
15-inch 2x2 skip	344,867	20.00	1,222	2,444
30-inch solid	301,094	10.00	611	1,222
30-inch 2x1 skip	307,560	15.00	916	1,833
60-inch solid	308,385	20.00	1,222	2,444
38-inch solid	301,894	12.67	774	1,548
38-inch 2x1 skip	309,641	19.00	1,161	2,321

[1]Estimated purchase price is 90% of the 2005 MSRP.

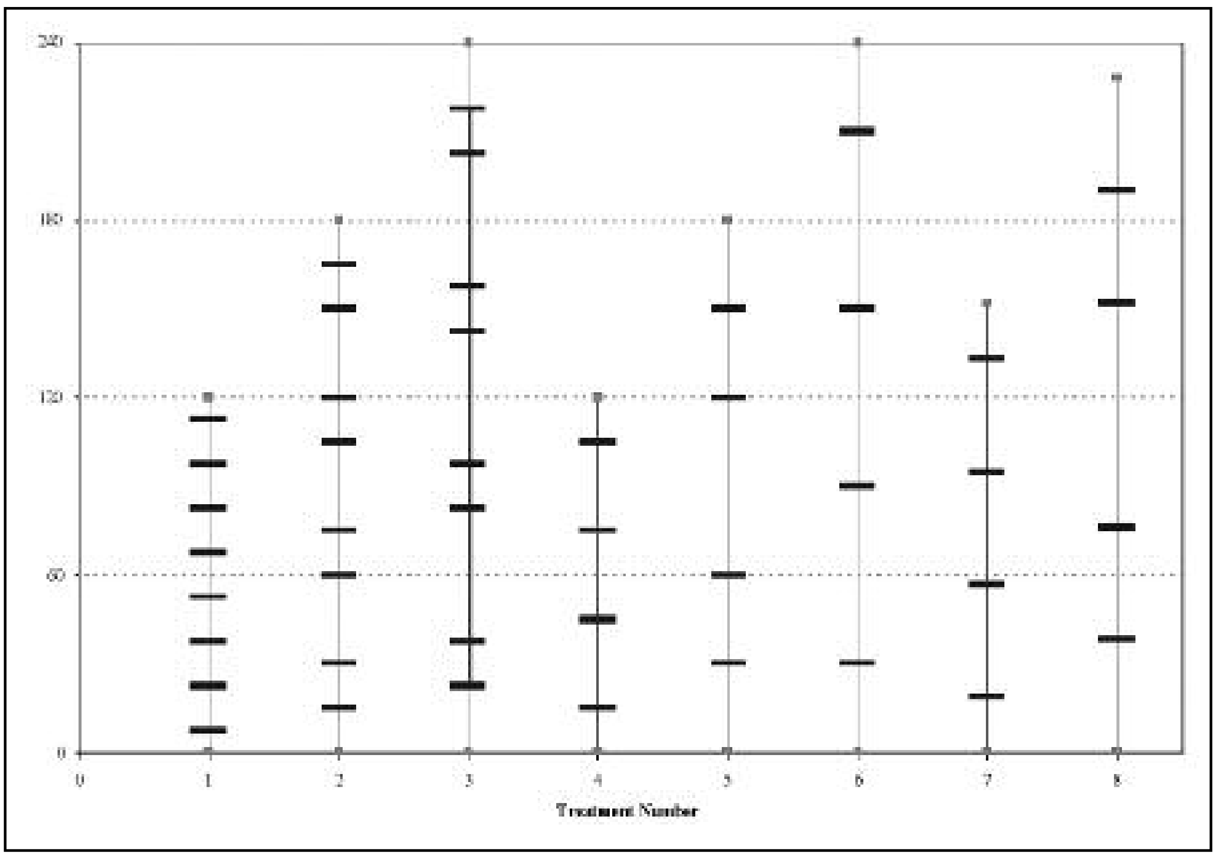

Figure 2. Row spacing and effective harvest swath width for the Hill farm (Verona and Falkner) four-row cotton picker unit, treatments 1-8.

culate the gross lint revenue. Gross revenue for each treatment and each year of the study was calculated using the Mississippi 2005 loan rate of $0.52 per pound with adjustments for the HVI fiber quality of each plot. A CD-ROM computer program by Falconer (2005) was used to calculate gross revenues. Cottonseed price was $94 per ton, and seed yield was estimated at 1.55 pounds of seed per pound of lint. Because seed was treated as a revenue item, a ginning charge of $0.08 per pound of lint and hauling charge of $0.02 per pound of lint were included as operating costs.

Operating costs were estimated with the Mississippi State Budget Generator (Laughlin and Spurlock 2003) using average prices that occurred in Mississippi during 2006. Operating costs per acre were estimated by multiplying an input's quantity per acre by its price. The seeding rate for treatments 1–6 was three per foot of row; for treatments 7 and 8, it was four per foot of row. Seed price was $0.40 per 1,000 with an additional technology fee of $0.93 per 1,000. The technology fee was capped at $49 per acre and took effect in treatments 1–4 and 7. Other operating cost items included fertilizer, herbicide, insecticide, growth regulator, harvest aid, labor, diesel fuel, haul and gin, repairs and maintenance for machinery, and interest on operating capital. In addition to seeding rate, some nitrogen fertilizer and postdirected herbicide application rates were directly related to the row length per

Table 3. JD 9996 picker with six-row-unit cotton picker information for the Delta (Clarksdale) farm.

Row pattern treatment	Estimated purchase price[1]	Swath width	Acres per picker	Acres per farm
	$	*ft*		
15-inch solid	384,687	15.0	916	2,749
15-inch 2x1 skip	389,867	22.5	1,375	4,124
15-inch 2x2 skip[2]	344,867	20.0	1,222	3,665
30-inch solid	370,922	15.0	916	2,749
30-inch 2x1 skip	373,403	22.5	1,375	4,124
60-inch solid[2]	308,385	20.0	1,222	3,665
38-inch solid	371,603	19.0	1,161	3,482
38-inch 2x1 skip[2]	309,641	19.0	1,161	3,482

[1]Estimated purchase price is 90% of the 2005 MSRP.
[2]Used a four-row unit picker.

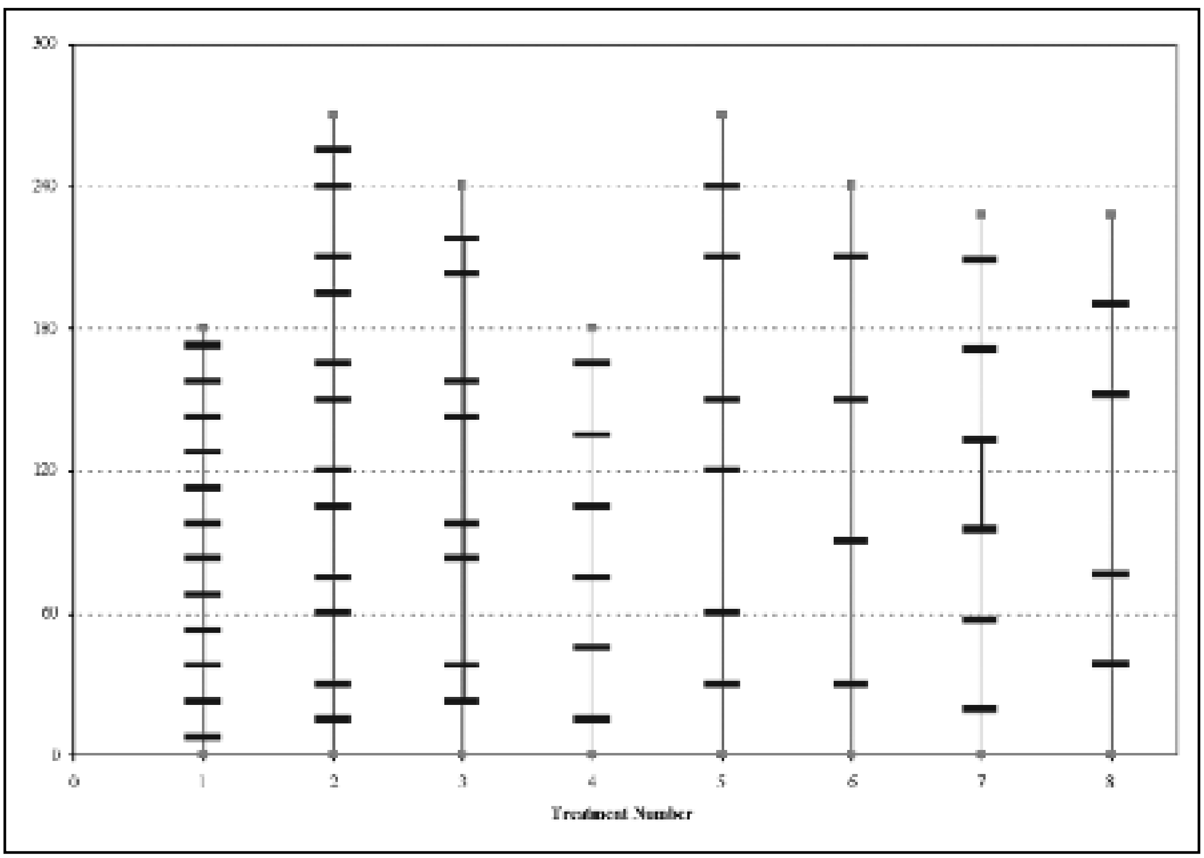

Figure 3. Row spacing and effective harvest swath width for the Delta farm (Clarksdale) six-row-unit cotton picker (treatments 1, 2, 4, 5, and 7) and four-row-unit picker (treatments 3, 6, and 8).

acre in each treatment row pattern, respectively. Some reductions in per-acre input usage and costs could be attained. The skip-row nitrogen fertilizer use was 90% of the solid-row patterns. The 15-inch, 2x1 skip-row pattern and the 15-inch, 2x2 skip-row pattern postdirect layby herbicide usage was 67% and 75%, respectively, of the 38-inch row solid.

The ownership cost for machinery items that were required for each farm was estimated on an annual basis by using the capital recovery method (Boehlje and Eidman 1984) at an interest rate of 5%. The per-acre ownership cost was calculated by dividing the total machinery ownership cost by the total farm acres for each row-pattern treatment. A land charge of $55 per acre was assigned to the Hill farms (Verona and Falkner) and $85 per acre for the Delta farm (Clarksdale). Overhead, management, and consultant fees were not included in the cost analysis. Except for the whole-farm analysis, all data for each location were analyzed with SAS Mixed Procedure program in the Statistical Analysis System (SAS) software (Littell et al. 1996). When no interactions were detected, the data were pooled over years. Means were separated using Fisher's Protected LSD calculated at the 5% significance level.

Results and Discussion

Wet soil conditions at Verona and Falkner in 2003 delayed planting until the last days of May. Planting was accomplished at all locations from April 27 to May 10 in 2004 and 2005 and mid-May in 2006. Above-normal rainfall during the growing season at all locations in 2003 and 2004 resulted in above-average yield. However, at Clarksdale in 2005, only 4.25 inches of rain fell from planting through August 26. Hurricane Rita in late September caused 20–30% yield losses (visual estimate). At Verona in 2005, the growing season had highly erratic rainfall: only 27% of normal rainfall for May; 17% above normal rainfall for June, all occurring the first 13 days of June; no rainfall from June 14 through July 4; 85% above normal rainfall for the rest of July; and no rainfall from August 1 through August 28. This erratic rainfall apparently had a negative effect on growth and yield, especially on 15-inch solid cotton. Falkner had excellent growing conditions all four seasons, except for dry conditions in mid-August 2005 and 2006.

At all locations, plant populations at harvest were good, with an 83% survival rate over all row patterns and years. At seeding rates of four per foot of planted row, the 38-inch, 2x1 skip-row pattern produced plant populations that were 67% of populations produced in the 38-inch, solid-row pattern at all locations. Seeding rates of three seeds per row foot resulted in different per-acre plant densities for all 15-inch and 30-inch row patterns at all locations. However, on a planted-acre basis, the plant populations at harvest for all row patterns, years, and locations were more than 30,000 plants per acre (data not shown). Seibert et al. (2005) reported that populations greater than 13,755 plants per acre in 38-inch rows had no negative effect on yield. The 15-inch solid pattern across years at all locations had the highest plant population at 70,000–84,000 per acre (data not shown). Wilson et al. (2005, 2006) reported that populations of 25,000–125,000 per acre for the 15-inch solid pattern had no negative effect on yield.

Yield and Plant Characteristics

Verona — Lint yield, plant height, and stem diameter showed a year-by-row-pattern interaction. Yields were inconsistent across years. The 15-inch solid pattern produced the highest yield in 2003 and 2004 but not in 2005 and 2006 (Table 4). In 2003, the 15-inch solid pattern yielded 1,196 pounds of lint per acre, which was equal to the yield of the 15-inch, 2x1 skip-row pattern

Table 4. Row pattern influence on lint yield in 2003–2006 and averaged over years, Verona.

Row pattern treatment	2003	2004	2005	2006	Avg.
	lb/A	*lb/A*	*lb/A*	*lb/A*	*lb/A*
15-inch solid	1,196	1,044	675	1,274	1,047
15-inch 2x1 skip	1,106	967	758	1,371	1,051
15-inch 2x2 skip	1,039	923	737	1,127	956
30-inch solid	1,038	987	758	1,303	1,022
30-inch 2x1 skip	813	844	724	1,196	894
60-inch solid	902	759	683	949	823
38-inch solid	922	855	827	1,312	979
38-inch 2x1 skip	810	797	669	1,064	835
Within year or row pattern LSD .05			149[1]		

[1]The LSD was calculated with an average of the standard errors.

but higher than other patterns. These results were similar to other studies (Wilson et al. 2005, 2007; Stephenson et al. 2007; Reddy et al. 2007) that reported increased yields with 15-inch rows. Yields were equal for the 30-inch solid; 15-inch, 2x2 skip-row; 15-inch, 2x1 skip-row; 60-inch solid; and 38-inch solid patterns. In 2004, yields from the 15-inch solid pattern were equal to yields from the 15-inch, 2x1 skip-row; 15-inch, 2x2 skip-row; and 30-inch solid patterns. In 2003 and 2004, yields from the 15-inch solid pattern were larger than yields from the 60-inch solid; 38-inch solid; 38-inch, 2x1 skip-row; and 30-inch, 2x1 skip-row patterns.

In 2005, yields were the lowest of all years due to alternating periods of excessive rainfall and drought. The 38-inch solid pattern had the highest yield, followed by the 15-inch solid and 38-inch, 2x1 skip-row patterns. There were no differences among the other patterns. 2006 had the highest yield of all years and across all row patterns. The early-season growing conditions were drier and warmer than the other years, resulting in increased growth. The 15-inch, 2x1 skip-row pattern had the highest lint yield (1,371 pounds per acre), but it was not different from the 15-, 30-, and 38-inch solid patterns. Except for the 38-inch, 2x1 skip-row pattern, the 60-inch solid pattern yielded less than all other patterns. The 15- and 30-inch solid yields were not different across all 4 years and were larger than the 38-inch solid in 2 of 4 years. In 3 of 4 years, there were no yield differences among the 15-inch solid; 15-inch, 2x1 skip-row; and 30-inch solid patterns. All 4 years, the 60- and 38-inch solid yields were similar and smaller than all other row patterns.

Plant height at maturity was quite variable across years (data not shown). The 15-inch, solid-row plant height ranged from 0–9 inches shorter than plants in 30- and 38-inch solid patterns. Most often, plant height in the 15-inch solid was 4–6 inches shorter than in the 30- and 38-inch row patterns.

The 15-inch solid pattern most often had smaller plant stem diameters at harvest than all other row patterns (data not shown). The plant stem diameters ranged from 0.24 inch in 2006 to 0.40 inch in 2003. This compared with 0.28–0.50 inch for 30- and 38-inch solid rows. Plant stem diameters in the 60-inch solid rows were similar but slightly larger than in the 30- and 38-inch solid rows.

Falkner — Lint yield, percent open bolls at defoliation, and plant height at harvest showed differences among row patterns with no year-by-row-pattern interaction (Table 5). The 4-year average lint yields ranged from 1,005 pounds per acre for the 60-inch, solid-row pattern to 1,278 pounds per acre for the 15-inch, solid-row pattern. Ranging from 1,199–1,278 pounds per acre, several patterns were not different in yield: 15-inch solid; 15-inch, 2x1 skip-row; 38-inch solid; and 30-inch solid. These yields were higher than the 38-inch, 2x1 skip-row pattern and the 60-inch solid pattern. There were no yield differences in the 15-inch, 2x1 skip-row; 15-inch, 2x2 skip-row; and 38- and 30-inch solid patterns. These results contrast with reported higher yields for 15-inch solid than wide-row cotton (Buehring et al. 2004, 2005, 2006; Willcutt et al. 2004, 2005, 2006; Wilson et al. 2005; Stephenson et al. 2007; Reddy et al. 2007). However, the results agree with other reports that 15-inch rows were equal to 38- or 40-inch rows (Balkcom et al. 2007; Gwathmey et al. 2007; Harrison et al. 2006).

Table 5. Lint yield, percent open bolls at defoliation, and plant height at harvest response to row pattern, averaged over years (2003–2006), Falkner.

Row pattern treatment	Lint	Open bolls	Harvest plant height
	lb/A	*%*	*in*
15-inch solid	1,278	50	32
15-inch 2x1 skip	1,245	44	36
15-inch 2x2 skip	1,179	47	36
30-inch solid	1,256	52	37
30-inch 2x1 skip	1,139	54	39
60-inch solid	1,005	56	39
38-inch solid	1,199	58	37
38-inch 2x1 skip	1,023	40	39
LSD .05	98	10	3

Maturity, based on percent bolls open at defoliation, indicated no difference between the 15-inch solid and all other row patterns (Table 5). However, the 60-inch solid rows had the highest percent open (56%) and were higher than the 15-inch, 2x1 skip-row and the 38-inch, 2x1 skip-row patterns. There was no difference among other row patterns. The 15-inch solid had 50% open bolls, compared with 52% for the 30-inch solid and 58% for the 38-inch solid. The number of rotten bolls per acre showed no year-by-row-pattern interaction, and there were no differences among row patterns (data not shown). Plant height at harvest for the 15-inch solid pattern was lower than all other row patterns (Table 5). Plant heights ranged from 32 inches for the 15-inch solid row to 39 inches for the 30-, 38-, and 60-inch solid patterns.

Plant stem diameters at harvest were highly variable across years. Larger diameters developed in 2003 and 2004, while smaller diameters developed in 2005 and 2006 (data not shown). The 15-inch solid stem diameters ranged from 0.24 inch in 2006 to 0.44 inch in 2003, which was 0.05–0.10 inch less than the 30- and 38-inch solid rows. Wider skip-row patterns resulted in larger stem diameters at harvest.

Clarksdale — Maturity (percent open bolls at defoliation), plant stem diameter at harvest, and rotten bolls showed no differences among years and row patterns and had no year-by-row-pattern interaction (Table 6). The 15-inch solid pattern, which had 61% open bolls, was not different from the 30-inch solid; 38-inch solid; 30-inch, 2x1 skip-row; 15-inch, 2x1 skip-row; and 15-inch, 2x2 skip-row patterns. However, it was higher than the 38-inch, 2x1 skip-row and the 60-inch solid patterns. These results were similar to those reported by Gwathmey and Steckel (2006) that wide skip rows delayed maturity.

Lint yield showed a year-by-row-pattern interaction. Yields in 2005 generally were lower than those in 2004. Lower yields in 2005 were caused by drought (4.25 inches of rainfall during the growing season) and 20–30% losses (visual estimate) from Hurricane Rita. 2004 had excellent growing conditions and no hurricane losses. The 15-inch solid, 30-inch solid, 38-inch solid, and 15-inch, 2x1 skip-row patterns showed no yield differences in 2004. These results were the same as other reports (Balkcom et al. 2007; Harrison et al. 2006; Gwathmey et al. 2007) that 15-inch row and 38- or 40-inch row yields were not different. The 30-inch solid pattern had the highest lint yield (1,397 pounds per acre), which was higher than the 30-inch, 2x1 skip-row; 60-inch solid; 38-inch, 2x1 skip-row; and 15-inch, 2x2 skip-row patterns. In 2005, the 15- and 38-inch solid patterns yielded 1,035 and 1,030 pounds per acre, respectively, which were not different but were higher than the 60-inch solid and the 38-inch, 2x1 skip-row patterns. These results contrast with reports of higher yields for 15-inch-row cotton (Beuhring et al. 2004, 2005, 2006; Willcutt et al. 2004, 2005, 2006; Wilson et al. 2005; Stephenson et al. 2007; Reddy et al., 2007).

The number of rotten bolls at harvest was low, ranging from 1,300 to 5,200 per acre (Table 6). The 15-inch, 2x1 skip-row pattern had the highest number of rotten bolls and was not different from the 15- and 30-inch solid rows. The 60-inch solid row had the lowest number of rotten bolls (1,300 per acre), which was not different from the 15-inch, 2x2 skip-row; 30-inch, 2x1 skip-row; 38-inch solid; and 38-inch, 2x1 skip-row patterns. Plant height at harvest was similar for both years, except that the 30-inch, 2x1 skip-row and the 60-inch solid patterns had taller plants in 2005 than 2004. In 2004, plants in the 15-inch, 2x1 skip rows were taller than those in the 30-inch, 2x1 skip rows, but they were not different from the other row patterns. In 2005, plant heights at harvest in the 15-inch solid rows were shorter than those in the 60-inch solid rows; all other row patterns were similar to the 15-inch rows.

Table 6. Lint yield and plant height at harvest, 2004 and 2005; percent open bolls at defoliation, plant stem diameter at harvest, and boll rot as influenced by row pattern, averaged over years, Clarksdale.

Row pattern	Lint			Harvest plant height		Open	Stem	Boll rot
treatment	2004	2005	Avg.	2004	2005	bolls	diameter	per acre
	lb/A	*lb/A*	*lb/A*	*in*	*in*	*%*	*in*	*x1,000*
15-inch solid	1,355	1,035	1,195	34	30	61	0.35	4.8
15-inch 2x1 skip	1,311	977	1,144	36	31	64	0.40	5.2
15-inch 2x2 skip	1,261	995	1,128	32	32	56	0.42	2.2
30-inch solid	1,397	972	1,185	32	32	61	0.43	3.5
30-inch 2x1 skip	1,168	1,004	1,086	29	36	54	0.51	2.5
60-inch solid	1,149	886	1,018	32	39	46	0.52	1.3
38-inch solid	1,358	1,030	1,194	33	34	55	0.40	2.6
38-inch 2x1 skip	1,273	843	1,058	33	34	47	0.42	1.8
Within row pattern								
LSD .05	111			6				
Within year								
LSD .05	111			6				
LSD .05						11	0.04	1.3

Table 7. HVI fiber properties and net loan price as influenced by years and averaged over row patterns (2003–2006), Verona.									
Year	MIC	Length	Uniformity	Strength	Elongation	Rd	Yellowness	Trash area	Net loan value
		in	*%*	*g/tex*	*%*	*%*	*+b*	*%*	*$/lb*
2003	3.8	1.09	82.8	29.92	5.58	78.20	7.89	0.994	0.575
2004	4.8	1.08	82.0	30.10	5.16	77.81	7.73	0.731	0.567
2005	4.3	1.07	79.6	29.69	4.78	78.41	7.15	0.519	0.550
2006	4.8	1.06	81.8	29.50	5.04	77.29	7.30	0.456	0.537
LSD.05	NS	NS	0.4	NS	0.15	0.42	0.10	0.08	0.007

HVI Fiber Properties

Verona — Yearly environmental effects had a greater impact on fiber quality than row patterns. Uniformity, micronaire, elongation, reflectance (Rd), yellowness (+b), and percent trash area showed differences among years but had no row-pattern-by-year interactions (Table 7). Micronaire ranged from 3.8–4.8 with no differences among years. The uniformity index ranged from 79.6–82.8%; 2005 had the lowest value. Uniformity values for all years were in the intermediate classification. Fiber strength ranged from 29.50–30.10 g/tex but showed no differences between years, and all were classified strong. 2003 had the highest elongation (5.58%), which was higher than 2004, 2005, and 2006 values. The lowest elongation (4.78%) occurred in 2005 and was lower than 2003, 2004, and 2006. The Rd values of 78.41 in 2005 and 78.20 in 2003 were equivalent and higher than the 2006 Rd. The Rd value for 2006 was lower than in 2003, 2004, and 2005. The fiber +b values were higher in 2003 and 2004 than in 2005 and 2006.

Strength, elongation, and percent trash area showed differences among row patterns, but these differences were minor. The net loan value showed row pattern differences with no year-by-row-pattern interaction (data not shown). The net loan price ranged from $0.537–0.575 per pound; 2006 had the lowest value (Table 7). Net loan values showed differences between each year.

Falkner — Row pattern had no influence on uniformity, Rd, +b, and fiber strength, and there were no row-pattern-by-year interactions. However, micronaire and fiber lengths showed differences among row patterns (data not shown). The micronaire measurements ranged from 4.0–4.3, but all values were in the USDA market classification base range. The fiber length for all row patterns ranged from 1.06–1.09 inches; however, the differences were less than 1⁄32 of an inch. The percent trash area of 0.99 for the 38-inch, 2x1 skip-row pattern was higher than all other row patterns. All other row patterns showed no differences.

Micronaire values showed differences between each year: 3.5 in 2003, 4.1 in 2004, 4.5 in 2005, and 4.9 in 2006 (Table 8). However, all of these values were in the market classification base range. Fiber lengths of 1.08 inches in 2003 and 1.10 inches in 2005 were not different but were 1⁄32 of an inch longer than fibers in 2004 and 2006 (1.06 inches). Fiber uniformity differences between each year were present, but all were in the intermediate market class range. Strength ranged from 27.3–29.9 g/tex. 2005 and 2006 showed no difference in strength values, and both were higher than 2003 and 2004, which had values of 28.9 and 27.3 g/tex, respectively.

Table 8. HVI fiber properties as influenced by years, averaged over row patterns, Falkner.								
Year	Mic	Length	Uniformity	Strength	Rd	Yellowness	Trash area	SFC
		in	*%*	*gm/tex*	*%*	*+b*	*%*	*%*
2003	3.5	1.08	82.5	28.9	77.71	8.57	0.98	10.87
2004	4.1	1.06	81.3	27.3	68.56	8.03	1.23	12.59
2005	4.5	1.10	81.0	29.9	78.39	7.14	0.51	8.65
2006	4.9	1.06	81.9	29.8	77.97	7.55	0.47	9.43
LSD.05	0.01	0.01	0.3	0.3	0.47	0.12	0.12	0.40

The reflectance (Rd) values ranged from 68.56–78.39 with 2004 having the lowest value of all years (Table 8). The lower reflectance in 2004 was possibly due to the month of rainy weather that occurred before harvest. 2005 and 2006 showed no difference in reflectance values. Yellowness (+b) values indicated there were differences among years. Percent trash area for 2004 was higher than all other years with no differences between 2005 and 2006, which had the lowest values of 0.51 and 0.47, respectively. In 2003, 2005, and 2006, net loan values showed no differences among row patterns (data not shown). In 2004, the 15-inch solid; 15-inch, 2x1 skip-row; 15-inch, 2x2 skip-row; and 30-inch solid patterns showed no difference in net loan price, but all were lower than the other row patterns.

Clarksdale — Row pattern and year had an interactive effect on fiber micronaire, length, Rd reflectance, and +b yellowness (Table 9). The micronaire values ranged from 3.8 for 60-inch solid rows in 2004 to 5.0 for the 30-inch solid row; 15-inch, 2x2 skip-row; and 38-inch, 2x1 skip-row patterns in 2005. The high micronaire in 2005 is possibly related to Hurricane Rita rainfall that occurred before harvest. Except for the 30-inch solid; 15-inch, 2x2 skip-row; and 38-inch, 2x1 skip-row patterns, the micronaire values for all row patterns were classified in the market class base range. Fiber length ranged from 1.07 inches in 2005 to 1.13 inches in 2004. The shorter length in 2005 was related to the summer drought. Within years 2004 and 2005, there were no row pattern differences in length, and the 38-inch, 2x1 skip-rows and the 30-inch, 2x1 skip-rows were the only row patterns that showed differences in fiber length compared across years. The reflectance values for all 2005 row patterns were lower than 2004. This was related to Hurricane Rita rainfall before harvest. In 2004, the 30-inch, 2x1 skip-row pattern's reflectance value of 81.28 was higher than the Rd of the 15-inch, 2x2 skip-row pattern, but it was not different from all other row patterns. Due to rainfall from Hurricane Rita, yellowness (+b) values were higher in 2005 than 2004, and some row patterns showed significant differences compared across years.

Percent trash area, net loan price, and uniformity showed differences among years (data not shown). Fiber uniformity for 2004 was higher than 2005. However, both values were in the intermediate USDA cotton market classification range. Trash area percent was higher in 2005 (0.34%) than 2004. Net loan value showed no differences in row patterns and no row-pattern-by-year interaction. But the net loan value for 2004 ($0.588 per pound) was higher than 2005 ($0.532 per pound). This difference in net loan value is possibly related to the lower reflectance, higher yellowness, and higher micronaire in 2005. Some row pattern micronaire values were as high as 5.0 in 2005; such ratings were in the cotton market classification discount range. The reflectance (Rd) values also were lower for all row patterns in 2005 than 2004, but there were no differences among row patterns in 2005. The yellowness values for all row patterns were higher in 2005 than 2004.

Table 9. HVI micronaire, fiber length, reflectance, and fiber yellowness as influenced by year and row pattern (2004–2005), Clarksdale.

Row pattern treatment	Mic		Length		Rd		Yellowness	
	2004	2005	2004	2005	2004	2005	2004	2005
			in	in	%	%	+b	+b
15-inch solid	4.2	4.7	1.10	1.10	80.43	73.58	7.63	8.63
15-inch 2x1 skip	4.2	4.7	1.10	1.07	80.10	74.65	7.88	8.27
15-inch 2x2 skip	4.2	5.0	1.12	1.10	79.50	74.69	7.73	8.40
30-inch solid	4.2	5.0	1.11	1.10	81.03	74.81	7.58	8.18
30-inch 2x1 skip	4.0	4.9	1.12	1.08	81.28	73.94	7.75	8.39
60-inch solid	3.8	5.0	1.12	1.10	80.35	75.13	7.83	8.09
38-inch solid	4.2	4.9	1.13	1.10	80.88	75.66	7.73	8.02
38-inch 2x1 skip	3.9	5.0	1.13	1.08	80.45	75.19	7.95	8.01
Within year LSD.05	0.2		0.03[1]		1.08[1]		0.26	
Across year LSD.05	0.3		0.03[1]		1.08[1]		0.31	

[1]LSD.05 across and within years.

Table 10. AFIS fiber properties as influenced by years, averaged over row patterns, Verona.										
Year	Neps	UQL (w)	SFC (w)	SFC (n)	Dust	Trash	Total trash	Trash size	VFM	MAT ratio
	no./g		*%*	*%*	*no./g*	*no./g*	*no./g*	*µm*	*%*	
2003	260	1.15	8.21	28.33	262	83	345	400	1.56	0.91
2004	242	1.16	12.22	36.39	339	97	436	384	1.94	0.86
2005	184	1.11	9.08	29.35	224	66	290	389	1.23	0.90
2006	145	1.12	7.28	24.83	225	86	311	429	1.57	0.95
LSD.05	12	0.01	1.47	2.90	28	8	36	10	0.16	0.02

AFIS Fiber Properties

Verona – AFIS fiber analysis indicated environment (years) generally had a greater impact on AFIS properties than row patterns. Row pattern had no effect on any AFIS fiber properties, and there was no row-pattern-by-year interaction. There were differences among years for neps, upper quartile length (UQL) by weight, short fiber content (SFC %) by weight and number [SFC (n)], total trash count, trash count, dust count, trash size, visible foreign matter (VFM), and maturity ratio (Table 10). Neps ranged from 145–260 per gram with differences between each year. The upper quartile length by weight ranged from 1.11–1.16 with differences between each year. Short fiber content [SFC (W)] by weight values ranged from 7.28 in 2006 to 12.22 in 2004. 2003 and 2005 showed no difference for SFC by weight, and 2006 was not different from 2003. Short fiber content number [SFC (n)] ranged from 24.83 in 2006 to 36.39 in 2004 and was different. There was no difference between 2003 and 2005 for SFC (n). The SFC number of 36.39 in 2004 was higher than in all of the other years.

Trash counts ranged from 66 per gram in 2005 to 97 per gram in 2004. The 2003 and 2006 trash counts of 83 and 86 per gram, respectively, were not different. The trash count of 97 per gram in 2004 was higher than in all other years. Dust counts of 224 per gram in 2005 and 225 per gram in 2006 were lower than 262 and 339 per gram in 2003 and 2004, respectively. The dust counts of 339 per gram in 2004 were higher than in all other years. Total trash content values of 436 per gram for 2004 were higher than in all other years. The total trash counts for 2003 and 2005 were not different. Trash size of 400 (µm) in 2003 was higher than in all other years. There were no differences in trash size for 2003 and 2004, but there were differences between 2003 and 2006.

Visible foreign mater (VFM) values ranged from 1.23 in 2005 to 1.94 in 2004. The values of 1.56 in 2003 and 1.57 in 2006 were not different, but they were lower than the values in 2004 and higher than those in 2005. Fiber maturity ratio ranged from 0.86 in 2004 to 0.95 in 2006. The values of 0.90 in 2003 and 0.91 in 2005 were not different. These values were higher than those in 2004 but lower than those in 2006. The maturity ratio values of 0.86 in 2004 and 0.90 in 2005 were classified (Uster 2004) as medium, whereas 2003 and 2006 values were classified as high. The upper quartile length [UQL (w)] by weight showed differences in years and row patterns with no interaction (data not shown). Upper quartile lengths for the 15-inch solid; 15-inch, 2x1 skip-row; 30-inch solid; and 38-inch solid patterns ranged from 1.12 to 1.14 and were not different. Upper quartile lengths for 38-inch solid; 15-inch, 2x2 skip-row; 30-inch, 2x1 skip-row; 60-inch solid; and 38-inch, 2x1 skip-row patterns ranged from 1.14 to 1.15 and were not different.

Falkner — Most often, year (environmental) effects were significant for all AFIS properties. Row patterns only affected neps, upper quartile length by weight, total trash, dust counts, and trash count (data not shown). There was no year-by-row-pattern interaction for these AFIS fiber properties. The 60-inch solid and 38-inch, 2x1 skip-row pattern neps counts of 250 and 255 per gram, respectively, were not different but were higher than counts in all other row patterns, except for the 30-inch, 2x1 skip-row pattern. The other row patterns showed no differences. The upper quartile length by weight ranged from 1.12 for the 15-inch solid and the 15-inch, 2x1 skip-row patterns to 1.15 for the 38-inch, 2x1 skip-row pattern. The 15-, 30-, and 38-inch solid and the 15-inch, 2x1 skip-row patterns showed no difference in upper quartile length by weight. The upper quartile length-by-weight values

Table 11. AFIS fiber properties as influenced by years, averaged over row patterns, Falkner.

Year	Neps	UQL (w)	SFC (w)	SFC (n)	Dust	Trash	Total trash	Trash size	VFM	MAT ratio
	no./g		*%*	*%*	*no./g*	*no./g*	*no./g*	*µm*	*%*	
2003	301	1.16	7.79	27.01	233	70	303	394	1.41	0.90
2004	296	1.11	10.46	33.19	363	88	450	366	1.80	0.89
2005	197	1.13	9.35	31.03	239	77	316	399	1.40	0.91
2006	144	1.12	7.23	24.04	214	68	283	402	1.27	0.97
LSD.05	15	0.01	0.52	1.09	41	10	49	12	0.21	0.01

were not different for the 15-inch, 2x2 skip-row; 30-inch, 2x1 skip-row; 60-inch solid; and 38-inch, 2x1 skip-row patterns.

Dust counts ranged from 228 per gram for the 15-inch solid pattern to 319 per gram for the 38-inch, 2x1 skip-row pattern. The 38-inch, 2x1 skip-row pattern had the highest dust count value of 319 per gram. It also was equal to the 30-inch, 2x1 skip-row pattern and the 15-inch, 2x2 skip-row pattern, but it was higher than all other row patterns. The 15-inch solid had the lowest dust count value (228 per gram) and was not different from the 15-inch, 2x1 skip-row; 30-inch solid; 30-inch, 2x1 skip-row; 60-inch solid; and 38-inch solid patterns. The 15-inch, 2x2 skip-row pattern had the highest trash count (90 per gram) and was not different from the 38-inch, 2x1 skip-row pattern and the 30-inch, 2x1 skip-row pattern. Total trash counts ranged from 293 per gram for 15-inch solid to 405 per gram for the 38-inch, 2x1 skip-row pattern. The 15-inch solid pattern total trash count (293 per gram) was equal to the 30-, 38-, and 60-inch solid patterns and the 15-inch, 2x1 skip-row pattern. The total trash count of 405 per gram for the 38-inch, 2x1 skip-row pattern was equal to the 15-inch, 2x2 skip-row pattern and the 30-inch, 2x1 skip-row pattern. It was higher than all other row patterns.

Verona — Years (environment) had a significant effect on neps, upper quartile length by weight, short fiber content by weight and number, dust count, trash count, total trash count, trash size, visible foreign matter, and maturity ratio (Table 11). There were no differences due to row pattern and no row-pattern-by-year interactions. Neps values of approximately 300 were present for all years. The upper quartile length-by-weight value of 1.16 in 2003 was higher than in all other years, and there were no differences in 2004, 2005, and 2006. The SFC by both weight and numbers showed differences between each year; 2004 had the highest value of 10.46% SFC (weight) and 33.19% SFC (number). Dust counts of 363 per gram, trash counts of 88 per gram, total trash counts of 450 per gram, and a visible foreign matter rating of 1.80 in 2004 were higher than in all other years. 2003, 2005, and 2006 showed no differences in trash counts, dust counts, total trash counts, and visible foreign matter. Trash size values ranged from 394–402 for all years. Maturity ratio values of 0.90 in 2003 and 0.89 in 2004 were not different. The 2006 maturity ratio value of 0.97 was the highest value and was different from the value in all other years.

Clarksdale — Dust counts, trash counts, total trash counts, short fiber content by weight and number, and visible foreign matter showed no response differences due to row patterns or years, and there were no year-by-row-pattern interactions (data not shown). Row pattern also had no effect on trash size and neps. However, there were differences among years for neps and trash size (data not shown). Neps of 266 per gram and trash size of 357 (µm) were higher in 2004 than in 2005, which had values of 136 neps per gram and trash size of 338 (µm).

There was a row-pattern-by-year interaction effect on upper quartile length by weight and maturity ratio (Table 12). All row patterns showed higher upper quartile length-by-weight values in 2004 than in 2005, except for the 15-inch, solid-row pattern, which showed no difference between 2004 and 2005. The upper quartile length values in 2004 ranged from 1.16–1.20. The 15-inch solid and the 15-inch, 2x1 skip-row patterns showed no differences and were lower than the 15-inch, 2x2 skip-row; 30-inch, 2x1 skip-row; 60-inch solid; and 38-inch, 2x1 skip-row patterns. The upper quartile length values were not different for the 38-inch, 2x1 skip-row; 60-inch solid; 30-inch, 2x1 skip-row; and 15-inch, 2x2 skip-row patterns. In 2005,

Row pattern treatment	UQL (w)		Maturity ratio	
	2004	2005	2004	2005
15-inch solid	1.16	1.15	0.92	0.92
15-inch 2x1 skip	1.17	1.13	0.92	0.92
15-inch 2x2 skip	1.19	1.14	0.93	0.94
30-inch solid	1.18	1.14	0.92	0.94
30-inch 2x1 skip	1.19	1.14	0.92	0.94
60-inch solid	1.19	1.15	0.91	0.94
38-inch solid	1.18	1.13	0.92	0.93
38-inch 2x1 skip	1.20	1.15	0.91	0.94
Within year LSD .05	0.01		0.02	
Across year LSD .05	0.02		0.02	

Table 12. AFIS upper quartile length and maturity ratio as influenced by year and row pattern (2004–2005), Clarksdale.

the 15-inch solid, 60-inch solid, and 38-inch, 2x1 skip-row patterns had upper quartile length values of 1.15. These values were higher than those for the 15-inch, 2x1 skip-row pattern and the 38-inch solid patterns, but they were not different from other row patterns. Maturity ratio ranged from 0.91–0.94, which was in the high category as described by Uster (2004). The 38-inch, 2x1 skip-row was the only pattern that showed maturity ratio differences between 2004 and 2005. No row patterns in 2004 and 2005 showed any difference for maturity ratio.

Whole-Farm Analysis

Verona — The 15-inch, 2x1 skip-row pattern had the highest lint yield average (1,051 pounds per acre), but its net returns above operating and machinery ownership cost per acre were similar to net returns for the 15-inch, 2x2 skip-row pattern (Table 13). The 15-inch, 2x2 skip-row pattern had lower lint yield, revenue, and machinery cost per acre, but its net returns per acre were similar to the 15-inch, 2x1 skip-row pattern. Lint yields of 1,021 pounds per acre for the 30-inch solid and 1,047 pounds per acre for the 15-inch solid were higher than lint yields for the 15-inch, 2x2 skip-row pattern. However, the smaller 10-foot harvest swath for these two row patterns resulted in the lowest cotton acreage, highest machinery ownership cost ($112 and $115 acre, respectively), and rankings of seventh and eighth in total whole-farm net revenue (Table 14). These results are similar to reports by Spurlock et al. (2006) using 2005 input prices where 15-inch solid showed the lowest whole-farm net returns. The 15-inch, 2x2 skip-row pattern had the largest acreage (widest harvest swath width) and provided the highest whole-farm net revenue ($155,917). The 15-inch, 2x1 skip-row pattern ranked second in net revenue. The 60-inch solid pattern had the same acreage as the 15-inch, 2x2 skip-row pattern, and it provided the third highest total whole-farm net revenue ($90,057).

Seed costs in the crop budget for the 15-inch solid were $23 per acre more than the 30- and 38-inch rows (data not shown). For the sake of comparison, the crop budget seed costs for the 15-inch solid were changed to be equal to the 30-inch solid. This change indicated the 15-inch solid lint yield would need to be increased by 226 pounds per acre in order for the 15-inch solid whole-farm net revenue to be equal to the 15-inch, 2x2 skip-row pattern.

The wider harvest swath (20 feet) for the 15-inch, 2x2 skip-row pattern — compared with a 10-foot swath for 15-inch solid — allowed a 100% increase in cotton acreage using the same equipment and harvest machinery complement. This increased acreage reduced the machinery ownership cost per acre by 44%, which con-

Table 13. Lint yield, revenue, and operating cost per acre for eight row patterns, averaged over years (2003–2006), Verona.

Row pattern treatment	Lint yield	Gross revenue	Operating cost	Net above op. cost	Machinery ownership cost	Net above op. + own. costs
	lb/A	*$/A*	*$/A*	*$/A*	*$/A*	*$/A*
15-inch 2x1 skip	1,051	655	451	204	84	120
30-inch solid	1,022	649	458	190	112	78
15-inch 2x2 skip	956	600	417	183	64	119
38-inch solid	979	618	440	178	89	89
30-inch 2x1 skip	894	567	400	168	77	91
15-inch solid	1,047	647	490	157	115	42
60-inch solid	823	520	369	151	59	92
38-inch 2x1 skip	835	532	387	145	63	82

Table 14. Whole-farm acreage, revenue, and operating cost for eight row patterns, Verona.

Row pattern treatment	Total acres	Total revenue	Operating cost	Machinery ownership cost	Land charge	Net revenue
		$	$	$	$	$
15-inch 2x2 skip	2,444	1,466,612	1,018,770	157,524	134,400	155,917
15-inch 2x1 skip	1,833	1,200,249	826,670	154,301	100,800	118,478
60-inch solid	2,444	1,271,356	901,757	145,143	134,400	90,057
30-inch 2x1 skip	1,833	1,039,372	732,390	140,858	100,800	65,324
38-inch 2x1 skip	2,321	1,234,677	898,803	145,580	127,680	62,614
38-inch solid	1,548	956,105	680,426	137,289	85,120	53,269
30-inch solid	1,222	792,677	560,075	136,840	67,200	28,562
15-inch solid	1,222	790,716	598,288	140,292	67,200	-15,064

tributed to higher whole-farm net revenue for the 15-inch, 2x2 skip-row pattern. The 38-inch solid pattern yielded 979 pounds of lint per acre, and it ranked sixth in total whole-farm net revenue. The 30-inch, 2x1 skip-row pattern yielded 894 pounds of lint per acre, ranking it fourth in total whole-farm net revenue. At 835 pounds per acre, the 38-inch, 2x1 skip-row pattern lint ranked fifth.

Falkner — The Falkner 15-inch solid results were similar to Verona. This row pattern had the highest 4-year lint yield average (1,278 pounds per acre) and the highest gross revenue per acre (Table 15). However, as at Verona, it also had the highest machinery ownership and operating costs per acre, as well as the smallest picker harvest swath and farm acreage. These factors resulted in the 15-inch solid having the lowest net returns per acre above operating plus machinery ownership cost, which resulted in the lowest whole-farm net revenue. These results are similar to Spurlock et al. (2005), who used Mississippi 2005 input prices in a study that showed 15-inch solid rows had the lowest whole-farm net revenue. The 60-inch solid lint yield average of 1,004 pounds per acre (79% of the 15-inch solid yield) had the lowest gross revenue. However, because it had the lowest operating and machinery ownership costs per acre of all treatments, it ranked second in whole-farm net revenue (Table 16).

The 15-inch, 2x2 skip-row pattern had a lint yield of 1,179 pounds per acre (92% of the 15-inch solid) and a farm acreage of 2,444 acres (twice that of 15-inch solid), which allowed it to earn the highest whole-farm net revenue ($354,966). The wider harvest swath for the 60-inch solid and the 15-inch, 2x2 skip-row pattern allowed the cotton acreage to increase 100% with the same equipment complement as the 30- and 15-inch solid. This factor reduced machinery ownership cost by 44% compared with the 15-inch solid and 42% compared with 30-inch solid. Both the 30- and 15-inch solid had similar yields (1,255 vs. 1,278 pounds per acre) and the smallest harvest swath width (10 feet), ranking them at seventh and eighth in whole-farm net revenue, respectively. The 38-inch solid yielded 1,199

Table 15. Lint yield, revenue, and operating costs per acre for eight row patterns, Falkner.

Row pattern treatment	Lint yield	Gross revenue	Operating cost	Net above op. cost	Machinery ownership cost	Net above op. + own. costs
	lb/A	*$/A*	*$/A*	*$/A*	*$/A*	*$/A*
30-inch solid	1,256	771	501	270	112	158
15-inch 2x2 skip	1,179	723	458	265	64	200
30-inch 2x1 skip	1,139	708	444	263	77	187
15-inch 2x1 skip	1,245	749	488	261	84	177
38-inch solid	1,199	741	480	261	89	172
15-inch solid	1,278	779	535	243	115	128
60-inch solid	1,005	623	407	216	59	157
38-inch 2x1 skip	1,023	635	424	211	63	148

Table 16. Whole-farm acreage, revenue, and operating costs for eight row patterns, Falkner.						
Row pattern treatment	Total acres	Total revenue	Operating cost	Machinery ownership cost	Land charge	Net revenue
		$	$	$	$	$
15-inch 2x2 skip	2,444	1,766,992	1,120,102	157,524	134,400	354,966
60-inch solid	2,444	1,522,898	994,982	145,143	134,400	248,374
30-inch 2x1 skip	1,833	1,296,768	813,919	140,858	100,800	241,191
15-inch 2x1 skip	1,833	1,373,086	895,072	154,301	100,800	222,913
38-inch 2x1 skip	2,321	1,475,020	985,289	145,580	127,680	216,471
38-inch solid	1,548	1,146,925	743,628	137,289	85,120	180,888
30-inch solid	1,222	941,920	611,880	136,840	67,200	125,999
15-inch solid	1,222	951,252	654,094	140,292	67,200	89,665

pounds of lint per acre and had a harvest swath of 12.7 feet, ranking it sixth in whole-farm net revenue. The 30-inch, 2x1 skip-row; 15-inch, 2x1 skip-row; and 38-inch, 2x1 skip-row patterns ranked third, fourth, and fifth in total whole-farm net revenue, respectively.

The 15-inch solid seed costs and technology fees were $23 per acre more than those costs in the 38- and 30-inch solid. For the sake of comparison, the crop budget seed cost per acre for the 15-inch solid pattern was made to equal seed cost for the 30-inch solid. Even with this change, the 15-inch solid lint yield would have to increase by 382 pounds per acre in order for this pattern's whole-farm net revenue to be equivalent to the 15-inch, 2x2 skip-row pattern.

Clarksdale — The 38-inch solid 2-year average lint yield was 1,194 pounds per acre, and the yield and gross revenue per acre were similar to the 15-inch solid (Table 17). However, the operating cost for 15-inch solid was $47 per acre more than for 38-inch solid; its machinery ownership cost was $26 per acre more. The machinery ownership cost for 38-inch solid was $8 per acre more than for the 15-inch, 2x1 skip-row pattern, which had a harvest swath of 22.5 feet and a lint yield of 1,144 pounds per acre (96% of 38-inch). Net revenue per acre above operating and machinery ownership costs for 38-inch solid was $75 per acre more than for 15-inch solid. The lower gross revenue for the 15-inch, 2x1 skip-row pattern was related to lower yield (96% of 38-inch yield) and lower net returns ($25 per acre less than 38-inch). The 38-inch solid pattern — which had a harvest swath width of 19 feet — had a farm size of 3,482 acres of cotton and had the highest whole-farm net revenue (Table 18). Conversely, the 30- and 15-inch solid patterns had 15-foot harvest swath widths and 2,749 farm acreage; these patterns ranked seventh and eighth in whole-farm net revenue, respectively. The 15-inch, 2x1 skip-row pattern ranked second, and the 15-inch, 2x2 skip-row pattern ranked third in whole-farm net returns.

Table 17. Per acre lint yield, revenue, and operating cost per acre for eight row patterns, Clarksdale.						
Row pattern treatment	Lint yield	Gross revenue	Operating cost	Net above op. cost	Machinery ownership cost	Net above op. + own. costs
	lb/A	$/A	$/A	$/A	$/A	$/A
38-inch solid	1,194	760	500	259	83	176
30-inch solid	1,185	750	509	240	105	136
15-inch 2x1 skip	1,144	722	497	226	75	151
15-inch 2x2 skip[1]	1,128	712	487	225	79	145
38-inch 2x1 skip[1]	1,058	672	462	211	76	134
15-inch solid	1,195	757	547	210	109	101
30-inch 2x1 skip	1,086	684	476	208	71	137
60-inch solid[1]	1,018	645	441	204	73	132

[1]Four-row-unit pickers used in the analysis; other treatments used six-row-unit pickers in the analysis.

Crop budget seed costs for the 15-inch rows were $23 per acre more than for the 30- and 38-inch rows (data not shown). For the sake of comparison, the seed cost in the crop budget for 15-inch rows was changed to equal the seed cost for 30-inch rows. Results indicated that the 15-inch solid yield would have to be increased by 144 pounds of lint per acre before that pattern's whole-farm net revenue would be equivalent to the 38-inch solid revenue. Although the Hill locations (Falkner and Verona) used a four-row harvester complement of equipment, the 30- and 15-inch solid rows across all locations had the lowest farm acreage and the highest machinery ownership cost per acre, which ranked them seventh and eighth, respectively, in whole-farm net revenue.

Table 18. Whole-farm acreage, revenue, and operating cost for eight row patterns, Clarksdale.

Row pattern treatment	Total acres	Total revenue	Operating cost	Machinery ownership cost	Land charge	Net revenue
		$	$	$	$	$
38-inch row	3,482	2,644,771	1,741,422	289,935	295,985	317,429
15-inch 2x1 skip	4,124	2,978,659	2,047,406	307,619	350,509	273,125
15-inch 2x2 skip[1]	3,665	2,608,453	1,784,875	290,401	311,564	221,613
30-inch 2x1 skip	4,124	2,820,618	1,963,614	291,922	350,509	214,573
38-inch 2x1 skip[1]	3,482	2,341,658	1,607,549	266,211	295,985	171,913
60-inch solid[1]	3,665	2,364,019	1,614,834	267,068	311,564	170,553
30-inch solid	2,749	2,061,539	1,400,552	287,321	233,673	139,993
15-inch solid	2,749	2,080,359	1,503,368	300,272	233,673	43,046

[1]Four-row-unit pickers used in the analysis; other treatments used six-row-unit pickers in the analysis.

CONCLUSIONS

The 15-inch solid rows produced shorter plants with smaller stem diameters than plants produced in 30- or 38-inch solid rows, and there were no major differences in boll rot and maturity. Averaged over years, the 15-inch solid rows yielded 2% more than the 30-inch rows and 7% more than the 38-inch rows in north Mississippi (Verona and Falkner); there were no differences for the north Mississippi Delta region (Clarksdale). The 15-inch skip-row patterns had higher yields than wide skip-row patterns. At Clarksdale, yields for the 15-inch, 2x1 and the 15-inch, 2x2 skip-row patterns ranged from 4–12% higher than yields from the 30-inch, 2x1 skip-row; 30-inch, 1x1 skip-row (60-inch row); and 38-inch, 2x1 skip-row patterns. At Verona and Falkner, yields from the 15-inch, 2x1 and the 15-inch, 2x2 skip-row patterns ranged from 3–22% higher than yields from the 30-inch, 2x1 skip-row; yields from the 15-inch skip-row patterns ranged from 15–22% higher than yields from the 38-inch, 2x1 skip-row and the 30-inch, 1x1 skip-row (60-inch solid row) patterns.

Except for Clarksdale, years (environments) had a greater impact on HVI and AFIS fiber properties than row patterns but showed little or no influence on gross revenue. The high rainfall amount from Hurricane Rita at Clarksdale affected reflectance and yellowness values, which resulted in lower net loan values in 2005 than 2004.

Using the maximum acreage per cotton harvester for each row pattern, the whole-farm revenue analysis indicated 30- and 15-inch, solid-row patterns had the smallest harvester swath width, lowest total farm cotton acreage, and highest machinery ownership cost per acre; these patterns ranked lowest (seventh and eighth) in whole-farm net revenue at all locations. The 15-inch, 2x2 skip-row pattern in the Hills and the 38-inch solid in the Delta produced the highest whole-farm net revenue. The 15-inch, 2x1 skip-row and the 15-inch, 2x2 skip-row patterns ranked second and third in total whole-farm net revenue at Clarksdale. These results suggest the 15-inch skip-row patterns may have greater potential than 15-inch solid rows for improving profitability.

The selected planting row pattern can have a substantial impact on both operating and ownership costs, as well as lint yield and net revenue. Therefore, when considering cotton row configuration options, emphasis should not only be on the row configuration's impact on lint yield, but also on the potential impact on picker harvesting capacity (picker swath width), whole-farm equipment operation efficiency, and total farm net revenue.

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