2003 BELTWIDE COTTON CONFERENCES, NASHVILLE, TN – JANUARY 6-10

THE EFFECT OF TILLAGE SYSTEM, ROW SPACING, EQUIPMENT SIZE, SOIL GROUP, AND VARIETY TYPE ON YIELDS, COSTS AND RETURNS, MISSISSIPPI DELTA, 2003

D.W. Parvin
Mississippi State University
Starkville, MS
S.W. Martin and F.T. Cooke
Delta Research and Extension Center
Stoneville, MS

Introduction

Researchers in the Department of Agricultural Economics, Mississippi State University, (DAE/MSU), in cooperation with scientists at other locations and other agencies began investigating alternative systems of cotton production during the 1999 production season (Parvin and Cooke, 1999). Initial research efforts focused on no-till (NT) cotton production (Parvin and Cooke, 2000; Parvin, Martin, and Cooke, 2002b; Parvin and Stephens, 2001b) and ultra-narrow row (UNR) cotton production systems (Parvin, Cooke, and Molin; Parvin, Martin, and Cooke, 2002a; Stephens and Parvin). While preliminary survey results indicated both systems were promising, the researchers found that cotton production systems based on skip-row (SXR) planting patterns (Parvin, Cooke, and McCarty; Parvin and Stephens, 2001a) were an attractive alternative to standard or traditional methods (systems) of cotton production on a large portion of Mississippi cotton acreage. Surveys designed to measure differences in NT, UNR, and SXR cotton production systems indicated an emerging system of production which the authors initially labeled "limited seedbed/chemical tillage" (LS/CT). These systems combine deep tillage and no-till systems of production (Parvin, Cooke, and Martin, 2002).

Many of the earlier publications proved to be very popular with growers, extension specialists, lending agencies, and others because they contained complete budgets for one or more sampled growers describing every "trip-across-the-field", listing each material applied and the amount applied. A limitation of the earlier reports was that they tended to compare a single alternative system of cotton production to the "standard" method of producing cotton in the Delta area of Mississippi (labeled "Cotton, 8R-40, Solid, Sandy Soil, Usual Practices, Standard Variety", in the DAE/MSU annual cost of production publications). This publication is a response to numerous requests to produce a single document which compares several systems of cotton production (old v. new, traditional v. alternative) across soils groups, variety types, planting patterns, tillage practices, and equipment size. This report summarizes 156 alternative systems of cotton production in terms of yield, costs, and returns.

Soils

The soils of the Delta area of Mississippi are typically divided into five major groups. Table 1 lists the groups and notes the abbreviations used in this report. Table 1 also provides an example soil name for each group and expresses each group as a percent of the total Delta area and as a percent of the Delta cotton soils.

Planting Patterns

Cotton is planted in many patterns. This report examines 3 patterns, solid planted cotton (SOL), skip-row cotton (SXR), and ultra-narrow-row cotton (UNR). SOL indicates equally spaced planted rows 40 inches apart. SXR is the same as SOL with every third row unplanted. This SXR pattern is often described as 40-inch 2x1 full skip. In this report UNR denotes solid planted cotton in 7.5-inch rows. This pattern is typically planted with a grain drill as opposed to the regular planter used for SOL and SXR. In this report, all UNR production systems are grown NT with genetically modified seed (GMS).

Yield

Cotton yield is primarily a function of soil productivity and planting patterns. Table 2 lists the yields employed in this report. From an agronomy standpoint, UNR cotton can be grown on SCL and DS soils. However, current technology (primarily plant growth regulators) does not exist to cost effectively control plant height on these soils so that the crop can be successfully harvested (stripped). To date, the authors have not observed commercial UNR cotton grown on these soils. This report provides no yield, costs, or returns information for UNR cotton grown on the two most productive soils in the Delta area of Mississippi.

Practices

This report examines three general sets of practices. Because each set involves a varying number of "trips-over-the-field" to "till" the soil, they are often referred to as tillage practices.

Traditional Tillage (TT)
The DAE/MSU has been labeling these practices as "usual practices" in their annual cost of production or crop budget publications. Today, TT probably best describes the way cotton "used to be" grown. TT practices include subsoiling at a 45-degree angle to the row, 6 "trips" prior to planting, and 4 cultivate and post after crop emergence.

Conservation Tillage (CT)
Authors have referred to this production system as limited seedbed/chemical tillage (Parvin, Cooke, and Martin) and reduced tillage (Parvin and Stephens, 2002a). Today the accepted term seems to be CT. CT systems are built around chemical cultivation after emergence and maintenance of old seedbeds. In these systems, down the row deep tillage (paratill) replaces subsoiling at a 45-degree angle to the row. The current regulatory definition is less than 4 trips that disturb the soil.

No-Till (NT)
In these systems the soil is not disturbed ("tilled"), except to repair damage done during a wet harvest season or to "rehip" the beds on an ad hoc basis (unscheduled), and only when absolutely necessary. NT systems are built around chemical weed control.

Variety Type

Variety type impacts direct cost (DC) and equipment fixed cost (FC). This report examines four variety types. Three are Monsanto's patented GMS.

Conventional (CON)
These production systems involve chemical herbicides and insecticides for weed and insect control. The seed for this variety type are not GMS.

Roundup Ready (RR)
This variety type contains a gene which allows "over-the-top" application of Monsanto's Roundup (a glyphosate herbicide) or a generic glyphosate substitute for Roundup.

Bollgard (Bt)
This variety type contains a gene which functions as an insecticide (the toxin is Bacillus Thuringinensis) for selected worm pests of cotton, especially the tobacco budworm. It reduces the number of foliar sprays with chemical insecticides.

Stacked BtRR
This variety type contains both the RR and the Bt genes.

Equipment Size

SOL and SXR production systems are presented for two equipment sizes; 8 row-40" (8R), and 12 row-40" (12R). Systems labeled "8R" are based on 8R planters and 4R pickers and 12R systems are built around 12R planters and 6R pickers.

In this publication the number of rows refer to the number of planted rows. The authors are yet to observe a 12R 2X1-40" full-skip planter or a 6R picker modified to harvest such a system. This report contains no information on 12R/SXR production system. Readers are referred to (Parvin, Cooke, and Martin; 2000; Parvin, Cooke, and Stephens, 2002a,b) for yield, costs, and returns on emerging 12R/SXR production systems.

UNR costs are presented for only one equipment complement. The UNR production systems are built around a 20' NT grain drill and a cotton stripper with a 13-foot header.

Lint and Seed Price

Cotton production results in two products, lint and seed. UNR cotton or stripper cotton lint is priced lower than spindle harvested (picker) cotton. The prices selected reflect price to the grower for program cotton (in 2003). The price per pound of lint is set at 72¢ for picker cotton and 68¢ for stripper cotton. The price of cottonseed is set at 5¢ per pound.

Methodology

During the 1999, 2000, 2001, and 2002 production seasons, detailed information on every trip-across-the-field was taken from commercial operations that employed the production systems summarized in this report. The Mississippi State Budget Generator (Laughlin and Spurlock) was utilized to construct per acre budget tables for each of the observations. The results summarized in this publication represent the "average" of multiple observations (adjusted to expected 2003 input and output prices).

Results

Per acre estimates are presented of the direct costs, fixed costs, and returns for each production system. Fixed costs reflect equipment (self-propelled and towed) fixed cost. Returns are "returns above specified costs" or returns above direct and fixed costs. Land, management, and general farm overhead costs are not addressed in this report.

Fixed Cost (FC)

FC is a function of equipment size, planting pattern, and tillage practices. Table 3 lists the estimates of per acre FC obtained for the productive systems summarized in this report. See Laughlin and Spurlock for a complete discussion of how FC is calculated or estimated. SXR-8R is less expensive than SOL-8R because SXR-8R is faster. It completes more acres per unit of time. It has a smaller performance rate (PR-hours/acre). While SOL-12R and SXR-8R has the same PR, SXR-8R is cheaper because the power unit (tractor) is smaller and the towed equipment is slightly less costly.

In terms of the FC associated with tillage practices, NT is cheaper than CT and CT is cheaper than TT. 12R is cheaper than 8R and SXR is cheaper than SOL. UNR is the least expensive, approximately 36% of the most expensive system.

Harvesting equipment is the largest component of equipment FC (table 4). Harvesting FC as a percent of total FC increases as the number of "trips-over-the-field" pre-harvest declines. Harvesting FC as a percent of total FC ranges from 54% for UNR to 80% for SOL/NT.

Direct Cost (DC)

Table 5 lists estimated direct cost per acre for 156 alternative systems of production. In terms of variety type, systems of production based on CON variety type have the largest DC. BtRR has the smallest DC. RR is less expensive than CON and Bt is cheaper than RR.

Relative to tillage practices, TT is the most expensive, and NT is the least expensive. CT is cheaper than TT and more expensive than NT. 12R is cheaper than 8R and SXR is less expensive than SOL.

Estimates of DC for UNR are presented only for NT and GMS. UNR is cheaper than SOL 8R and SOL 12R, but slightly more expensive than SXR.

DC of the various systems increases with soil productivity (yield) because each additional pound of yield required $0.10 for the DC associated with hauling and ginning. Therefore, given a system (planting pattern/equipment size/tillage practice/variety type), soil SC is the cheapest and DS is the most expensive.

The DC associated with soils SC is $5.72 more expensive per acre than SS, SCL, or DS primarily due to the heavier rates of herbicide associated with the added clay context of SC soils. The DC associated with 12R systems relative to 8R systems varies by tillage practices due to the number of trips-over-the-field, which vary from TT to CT to NT. TT/12R is $21.85 cheaper per acre than TT/8R. CT/12R is $17.50 less expensive than CT/8R and NT/12R is $14.15 cheaper than NT/8R.

Returns

In general per acre estimated net returns above specified costs improve by soil group as yield increases from SC to SS to SCL to DS (Table 6). They improve by variety type from CON to RR to Bt to BtRR, from 8R to 12R, and from SOL to SXR. The exception is soil SC, which does not respond to SXR. Soils SS, SCL, and DS compensate for the "skip" in terms of yield while soil SC does not. Therefore, the best returns on a SC soil with a CON variety is 12R/SOL/NT ($105.44). Maximum returns on SC soils are associated with GMS and UNR (all UNR is NT).

The best returns on an SS soil with a CON variety is SXR/NT ($236.03). Maximum returns on SS soils are the same for UNR and SXR/NT. The cost savings associated with SXR almost exactly offsets the 30-pound yield advantage assumed for UNR (Table 2).

On the area's two most productive soils (SCL and DS), maximum returns are obtained by employing GMS (BtRR) in a SXR/NT production system.

Discussion

In terms of DC, relative to CON variety type, RR is worth (less costly) $19.19 per acre, Bt is worth $27.57, and BtRR is worth $46.76. On average, in terms of tillage practices, CT is worth $30.17 per acre more than TT, and $58.06 - $30.17 or

$27.89 less than NT (NT is worth $58.06 more than TT). The improvement in DC associated with 12R relative to 8R varies by tillage practices (TT, CT, NT). TT/12R is worth $21.85 per acre more than TT/8R. CT/12R is $17.50 less expensive than CT/8R, and NT/12R is $14.15 cheaper than NT/8R. Differences by tillage practices are due to differences in the number of "trips-over-the-field" and its impact on equipment, labor, and fuel DC per acre. SXR is worth $68.42 per acre more than SOL. Recall, all UNR is grown NT with GMS, relative to SOL/8R/NT/BtRR, UNR/NT/BtRR is worth $62.28 per acre.

Net revenue (NR) above specified costs is a function of gross revenue (yield and price), DC and FC. Yield varies by soil group and planting pattern. Price varies by planting pattern (picker v. stripper harvest). DC is a function of soil group, planting pattern, equipment size, tillage practice, and variety type. FC is a function of planting pattern, equipment size, and tillage practice. Production system, SOL/8R/TT/SC/RR, has an estimated NR of $24.28 per acre. SOL/12R/CT/SS/Bt has an estimated NR or $193.86. A producer that changes from a SOL/8R/TT/SCL/CON to an SXR/8R/NT/SCL/BtRR system will improve his NR by ($338.75 - $171.70) or $167.05 per acre.

Summary and Limitations

Production systems based on wider equipment and fewer "trips-over-the-field" reduce costs and improve returns. SXR systems are especially efficient as long as assumed yields can be maintained.

Days suitable for harvest per season and hours suitable for harvest per day are reduced for strippers relative to pickers. The risks associated with agronomic yield and economic or realized yield need additional research. The percent of agronomic yield delivered to the gin (economic yield) may be less for UNR or stripper systems than spindle or picker systems. If this is true, the costs associated with UNR are biased downward and the returns associated with UNR are biased upward.

Returns reported in this publication are especially sensitive to assumed yields. Reasonable individuals can disagree on the absolute magnitude and/or relative magnitude of all the assumed yields utilized in this report.

References

Laughlin, David H. and Stan R. Spurlock. 2001. Mississippi State Budget Generator User's Guide, Version 5.4 for Windows. Department of Agricultural Economics, Mississippi State University. Online at: ftp://web.agecon.msstate.edu/pub/laughlin/MSBG5.4.htm.

Parvin, D.W. and F. T. Cooke. 1999. Current adjustments to cotton's high production cost and low price by Mississippi producers. Staff Report 99-002, Department of Agricultural Economics, Mississippi Agricultural & Forestry Experiment Station, Mississippi Cooperative Extension Service, Mississippi State University.

Parvin, D.W. and F. T. Cooke. 2000. Costs, yields, and net returns, commercial no-till cotton production, Mississippi, 1999. Research Report 2000-001, Department of Agricultural Economics, Mississippi Agricultural & Forestry Experiment Station, Mississippi Cooperative Extension Service, Mississippi State University.

Parvin, D.W., F.T. Cooke, and S.W. Martin. 2000. Estimated costs and returns, ten cotton production systems, Mississippi, 2000. Research Report 2000-011, Department of Agricultural Economics, MAFES/MCES, Mississippi State, University.

Parvin, D.W., F.T. Cooke, and S. W. Martin. 2002. The 2001 experience of ten Mississippi producers with limited seedbed/ chemical tillage cotton production. Staff Report 2002-003, Department of Agricultural Economics, MAFES, MSU-ES, MSU.

Parvin, D.W., F. T. Cooke and Will McCarty. 1999. The impact of current cotton price and production costs on skip-row cotton. Research Report 99-004, Department of Agricultural Economics, Mississippi Agricultural & Forestry Experiment Station, Mississippi Cooperative Extension Service, Mississippi State University.

Parvin, D.W., F.T. Cooke, and W.T. Molin. 2000. Commercial ultra-narrow row cotton production, Mississippi, 1999. Proceedings of Beltwide Cotton Conference, National Cotton Council of America, San Antonio, Texas.

Parvin, D.W., F. T. Cooke, and J. D. Stephens. 2000a. Estimated costs, yields, and returns associated with 8-row, 12-row, and 12-row skip-row cotton production systems. Staff Report 2000-02, Department of Agricultural Economics, Mississippi Agricultural & Forestry Experiment Station, Mississippi Cooperative Extension Service, Mississippi State University.

Parvin, D.W., F. T. Cooke, and J. D. Stephens. 2000b. Estimated costs, yields, and returns associated with 8-row solid and 12-row skip-row cotton production systems: A case study. Staff Report 2000-003, Department of Agricultural Economics, Mississippi Agricultural & Forestry Experiment Station, Mississippi Cooperative Extension Service, Mississippi State University.

Parvin, D.W., S.W. Martin, and F.T. Cooke. 2002a. The 2001 experience of twelve Mississippi producers with ultra-narrow-row cotton. Staff Report 2002-2001, Department of Agricultural Economics, MAFES/MSU-ES/MSU.

Parvin, D.W., S.W. Martin, and F.T. Cooke, 2002b. The 2001 experience of twelve Mississippi producers with no-till cotton production. Staff Report 2002-002, Department of Agricultural Economics, MAFES/MSU-ES/MSU.

Parvin, D.W. and J.D. Stephens. 2001a. The economics of solid versus skip-row cotton production, usual practices versus reduced tillage, Mississippi, 2001. AEC Research Report 2001-004, Department of Agricultural Economics, MAFES, MSU-ES, MSU.

Parvin, D.W. and J.D. Stephens. 2001b. No-till cotton production in Mississippi. Proceedings of Beltwide Cotton Conferences, National Cotton Council of America, Anaheim, California.

Stephens, Dudley and Dave Parvin. 2001. Ultra-narrow-row cotton production in Mississippi: 2000 update. Agricultural Economics Research Report 2001-005. Department of Agricultural Economics, Mississippi Agricultural & Forestry Experiment Station, Mississippi Cooperative Extension Service, Mississippi State University.

Table 1. Major Soil Groups, Delta Area of Mississippi.

Soil Group	Abbreviation	Example	% of Area	% of Delta Cotton Soils
Deep Sand	DS	Bosket	9	23
Silty Clay Loam	SCL	Dundee	13	32
Shallow Sand	SS	Forestdale	12	30
Silty Clay	SC	Sharkey	6	15
Clay	CL	Alligator	60	0

Table 2. Yield (lbs. of lint/acre) by Soil Group and Planting Pattern, Delta Area of Mississippi.

Soil	----- Planting Patterns -----		
Group	SOL	SXR	UNR
DS	1020	925	NA
SCL	930	875	NA
SS	825	795	825
SC	700	500	700

Table 3. Per Acre Equipment Fixed Cost by Planting Pattern, Equipment Size, and Tillage Practice, Delta Area of Mississippi, 2003.

	TT	CT	NT
SOL-8R	81.82	71.41	63.32
SOL-12R	68.97	61.41	53.69
SXR-8R	58.25	52.68	46.54
UNR	NA	NA	29.52

Table 4. Harvesting Fixed Cost as a Percent of Total Fixed Cost.

	TT	CT	NT
SOL-8R	62	71	80
SOL-12R	62	70	80
SXR-8R	56	61	68
UNR	NA	NA	54

Table 5. Estimated Direct Cost Per Acre, 156 Alternative Systems of Cotton Production, Delta Area of Mississippi, 2003.

Planting Pattern	Equipment Size	Tillage Practice	Variety Type	----- Soil -----			
				SC	SS	SCL	DS
SOL	8R	TT	CON	472.73	479.51	490.01	499.01
			RR	453.54	460.32	470.82	479.82
			Bt	445.16	451.94	462.44	471.44
			BtRR	425.97	432.75	443.25	452.25
		CT	CON	442.56	449.34	459.84	468.84
			RR	423.37	430.15	440.65	449.65
			Bt	414.99	421.77	432.27	441.27
			BtRR	395.80	402.58	413.08	422.08
		NT	CON	414.67	421.45	431.95	440.95
			RR	395.48	402.26	412.76	421.76
			Bt	387.10	393.88	404.38	413.38
			BtRR	367.91	374.69	385.19	394.19
	12R	TT	CON	450.88	457.66	468.16	477.16
			RR	431.69	438.47	448.97	457.97
			Bt	423.31	430.09	440.59	449.59
			BtRR	404.12	410.90	421.40	430.40
		CT	CON	425.06	431.84	442.34	451.34
			RR	405.87	412.65	423.15	432.15
			Bt	397.49	404.27	414.77	423.77
			BtRR	378.30	385.08	395.58	404.58
		NT	CON	400.52	407.30	417.80	426.80
			RR	381.33	388.11	398.61	407.61
			Bt	372.95	379.73	390.23	399.23
			BtRR	353.76	360.54	371.04	380.04
SXR	8R	TT	CON	387.31	411.09	419.09	424.09
			RR	368.12	391.90	399.90	404.90
			Bt	359.74	383.52	391.52	396.52
			BtRR	340.55	364.33	372.33	377.33
		CT	CON	357.14	380.92	388.92	393.92
			RR	337.95	361.73	369.73	374.73
			Bt	329.57	353.35	361.35	366.35
			BtRR	310.38	334.16	342.16	347.16
		NT	CON	329.25	353.03	361.03	366.03
			RR	310.06	333.84	341.84	346.84
			Bt	301.68	325.46	333.46	338.46
			BtRR	282.49	306.27	314.27	319.27
UNR	-	NT	RR	330.20	339.98	NA	NA
			Bt	324.82	331.60	NA	NA
			BtRR	305.63	312.41	NA	NA

Table 6. Estimated Per Acre Net Returns Above Specified Costs, 156 Alternative Systems of Cotton Production, Delta Area of Mississippi, 2003.

Planting Pattern	Equipment Size	Tillage Practice	Variety Type	----- Soil -----			
				SC	SS	SCL	DS
SOL	8R	TT	CON	5.09	98.25	171.70	234.66
			RR	24.28	117.44	190.89	253.85
			Bt	32.66	125.82	199.27	262.23
			BtRR	51.85	145.01	218.46	281.42
		CT	CON	45.68	138.84	212.29	275.25
			RR	64.87	158.03	231.48	294.44
			Bt	73.25	166.41	239.86	302.87
			BtRR	92.44	185.60	259.05	322.01
		NT	CON	81.66	174.82	248.27	311.23
			RR	100.85	194.01	267.46	330.42
			Bt	109.23	202.39	275.84	338.80
			BtRR	128.42	221.58	295.03	357.99
	12R	TT	CON	39.80	132.96	206.41	269.37
			RR	58.99	152.15	225.60	288.56
			Bt	67.37	160.53	233.98	296.94
			BtRR	86.56	179.72	253.17	316.13
		CT	CON	73.13	166.29	239.74	302.70
			RR	92.32	185.48	258.93	321.89
			Bt	100.70	193.86	267.31	330.27
			BtRR	119.89	213.05	286.50	349.46
		NT	CON	105.44	198.60	272.05	335.01
			RR	124.63	217.79	291.24	354.20
			Bt	133.01	226.17	299.62	362.58
			BtRR	152.20	245.36	318.81	381.77
SXR	8R	TT	CON	-45.81	166.26	222.22	257.20
			RR	-26.62	185.45	241.41	276.39
			Bt	-18.24	193.83	249.79	284.77
			BtRR	0.95	213.03	268.99	303.97
		CT	CON	-10.07	202.00	257.96	292.94
			RR	9.12	221.19	277.15	312.13
			Bt	17.50	229.57	285.53	320.51
			BtRR	36.69	248.76	304.72	339.70
		NT	CON	23.96	236.03	291.99	326.97
			RR	43.15	255.22	311.18	346.16
			Bt	51.53	263.60	319.56	354.54
			BtRR	70.72	282.79	338.75	373.73
UNR	-	NT	RR	170.53	255.44	NA	NA
			Bt	175.91	263.82	NA	NA
			BtRR	195.10	283.01	NA	NA