Bootheel Irrigation Survey
1997 - 2005

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Average irrigated acreage of those surveyed: 878 acres

Average acreage irrigation increase planned for next season: 5.8%

- 21% of new irrigated land will be fixed pivots
- 7 % of new irrigated land will be towable pivots

I. Systems Used (based on acreage)

Furrow, rigid pipe	9 %	Furrow, rigid using surge	1 %
Furrow, poly-pipe	29 %	Furrow, poly-pipe using surge	7 %
Center pivot, towable	12 %	Center pivot, fixed	44 %

II. Irrigation Fuel Costs

Energy costs have risen for all fuel types. Figure 1 shows reported energy cost per acre by fuel type.

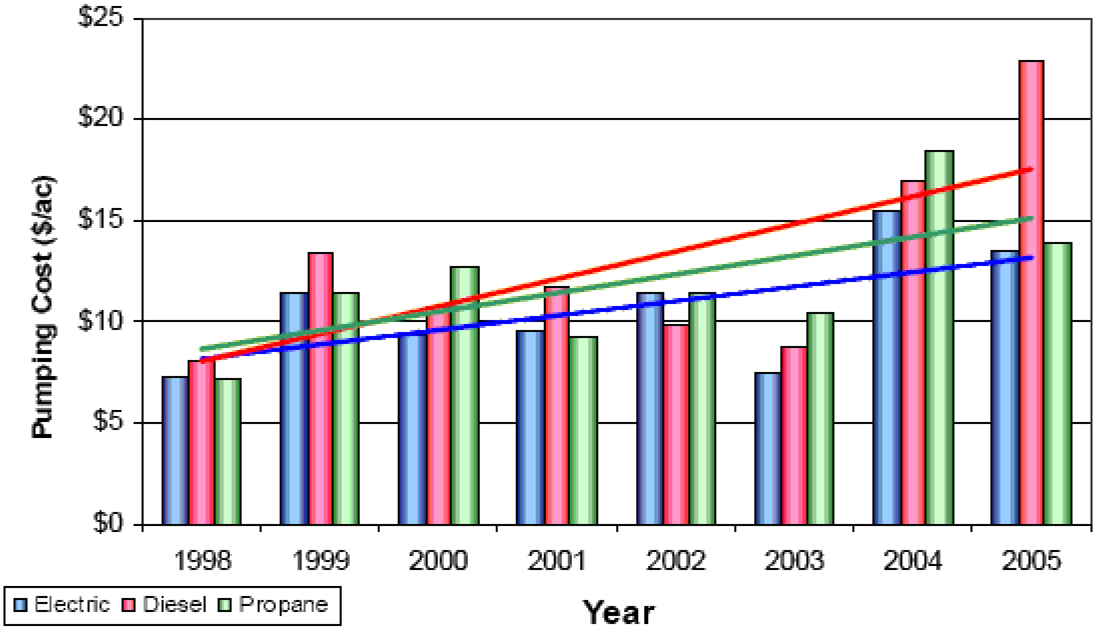

Fig. 1 - Cost on energy for pumping (corn, cotton, and soybean only) by fuel type, southeast Missouri region, 1997-2005.

III. Maintenance and Repairs

Table 1. Maintenance and Repair Cost, Bootheel of Missouri, 2002

	Per Farmer	Per Well	Per Acre
Wells	$1,444	$ 138	$ 1.65
Pumps	$1,571	$ 150	$ 1.79
System (average all types)	$2,577	$ 246	$ 2.94
Total	$5,592	$ 534	$ 6.37

note: 83.8 acres/well site *10.5 wells per farmer*

IV. How Effective Is Irrigation?

Despite receiving nearly 50 inches of annual rainfall, irrigation still increases yields in southeast Missouri. In the period 1997-2005, irrigation increased production over dryland yields by 39%, 27%, 60%, and 56% for corn, cotton, full-season soybeans, and double-crop soybeans, respectively. While these increases are substantial, farmers sometimes reported that their irrigated yield was no greater, or actually even less, then their dryland yields. Cotton was the crop that was most likely not to have a yield increase from irrigation (this occurs in about 1 out every 11 fields), which reflects the fact that irrigation of cotton in a sub-humid area is challenging. Even excellent cotton irrigators occasionally had fields that did not show a yield increase from irrigation. Despite the fact that cotton had occasions where no yield was gained from irrigation, its average yield increase produced the highest gross profits of any other commodity. Table 2 shows the percentage of time yield increase did not occur.

Table 2. Percentage of respondents who reported no yield gain from irrigation, southeastern Missouri region, 1997-2005.

Corn	5.6%
Cotton	9.3%
Full-Season Soybeans	8.2%
Double-Crop Soybeans	4.0%

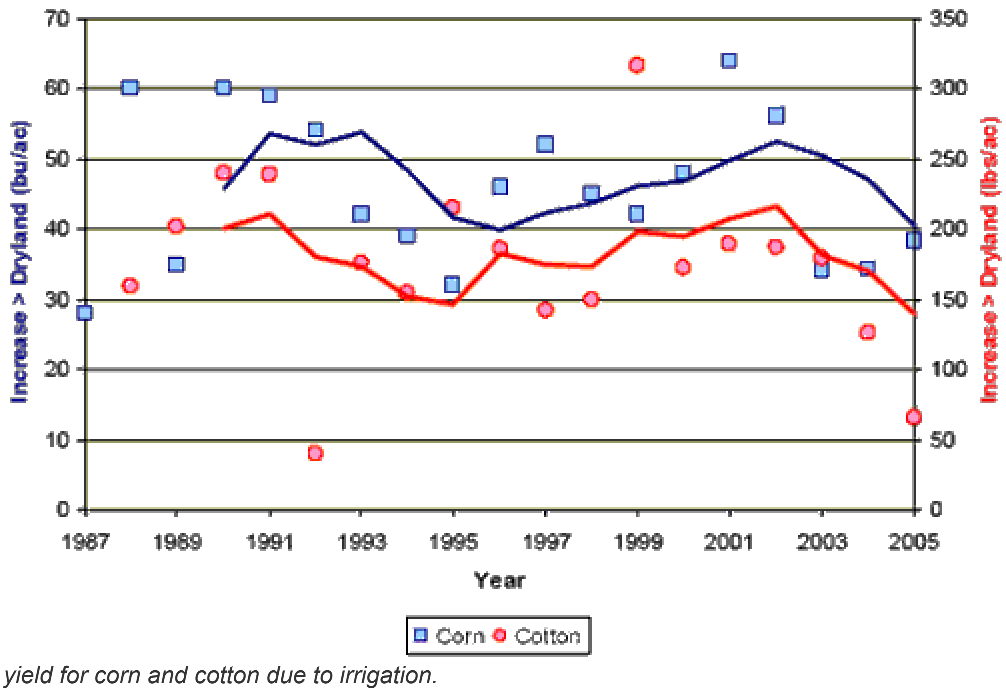

Fig. 2 - Increase in yield for corn and cotton due to irrigation.

The increase in yield stemming from irrigation is shown in Fig. 2 (corn and cotton) and Fig. 3 (full- and double-crop soybeans). Both figures have running-average trend lines shown. This yield difference of irrigated over dryland is the best way to quantify a region's irrigation expertise. An increase in the yield enhancement over time for soybeans can be seen, meaning that soybean irrigators are becoming more astute. In the last three or four years, Missouri has experienced excellent yields in most crops. Non-irrigated crops tend to especially benefit from these good growing seasons, so the yield difference between dryland and irrigated becomes less in those bumper years, and is shown in the trend lines decreasing in recent years.

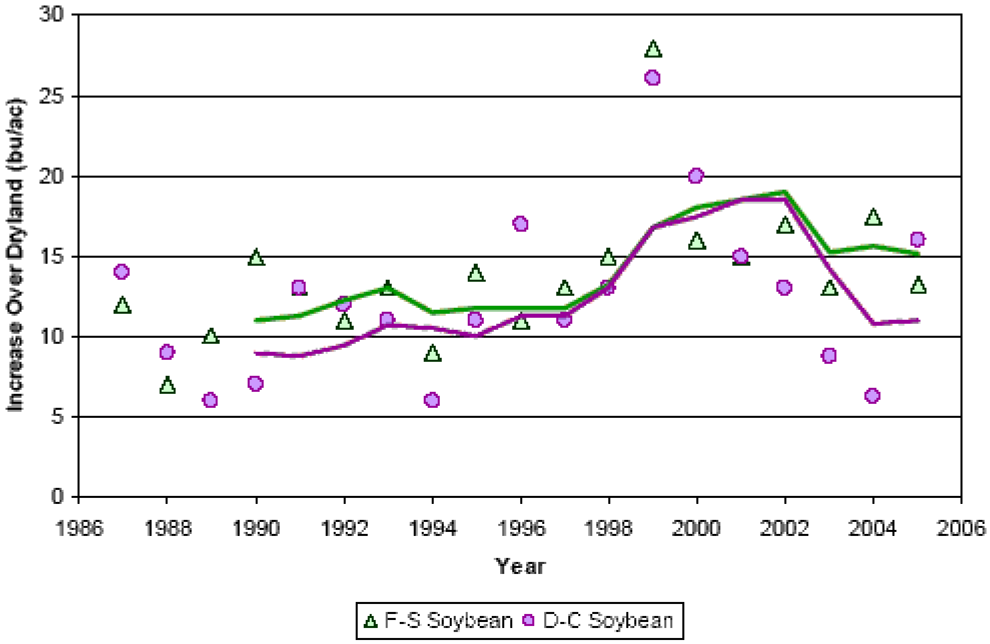

Fig. 3 - Increase in yield for full- and double-crop soybean due to irrigation.

V. Irrigation Practices Affecting Yield

1. Irrigation Scheduling. Irrigation scheduling improves yields for all crops. Irrigators, who used scheduling, when compared to their counterpart irrigators who did not schedule, out-yielded them by 11 bu/acre corn, 169 lbs lint/ac cotton, 5 bu/acre full season soybeans, and 3 bu/acre double crop soybeans (Table 3). Corn irrigators are the most likely to schedule, but in recent years increased numbers of cotton producers have adopted scheduling. Scheduling increases the number of irrigations applied per season. Those that schedule irrigate approximately one additional time more for flood and about three additional times more for pivot then do non-schedulers. The economic advantage from scheduling is greatest for the cotton irrigators, who would gross $110 more per acre then their counter parts who did not employ scheduling. The economic advantage gained by scheduling for the other crops were $30/acre, $29/acre, and $14/acre for corn, full season soybeans, and double crop soybeans, respectively. The *Arkansas Scheduler* computer program and the Woodruff charts appear to be equally effective; both are free, and can be obtained at:

http://www.aragriculture.org/computer_programs/irrigation_scheduling/default.asp
http://agebb.missouri.edu/irrigate/woodruff/

Table 3. Yields of crops based on irrigation scheduling method employed, samples size and % users, plus yield benefit from scheduling irrigation, southeast Missouri region, 2000-2005

Crop	**No scheduling method**	**Scheduling Methodologies**			**Benefit from using irrigation scheduling**
		***Ark. Scheduler* computer program**	**Woodruff irrigation charts**	**Sensors**	
Corn	171.2 bu/ac 72 % of users n = 174	179.9 bu/ac 13 % of users n = 31	180.6 bu/ac 15 % of users n = 36	193.0 bu/ac 0.4 % of users n = 1	+ 10.8 bu/ac 6 % increase
Cotton	900 lbs/ac 76 % of users n = 91	1033 lbs/ac 18 % of users n = 22	1061 lbs/ac 4 % of users n = 5	1250 lbs/ac 1 % of users n = 1	+ 169 lbs/ac 19 % increase

Full Season Soybean	44.9 bu/ac 87 % of users n = 140	50.3 bu/ac 9 % of users n = 14	49.1 bu/ac 4 % of users n = 7	---	+ 5.2 bu/ac 12 % increase
Double Crop soybean	39.3 bu/ac 90 % of users n = 75	43.9 bu/ac 6 % of users n = 5	45.0 bu/ac 4 % of users n = 3	---	+ 2.5 bu/ac 6 % increase

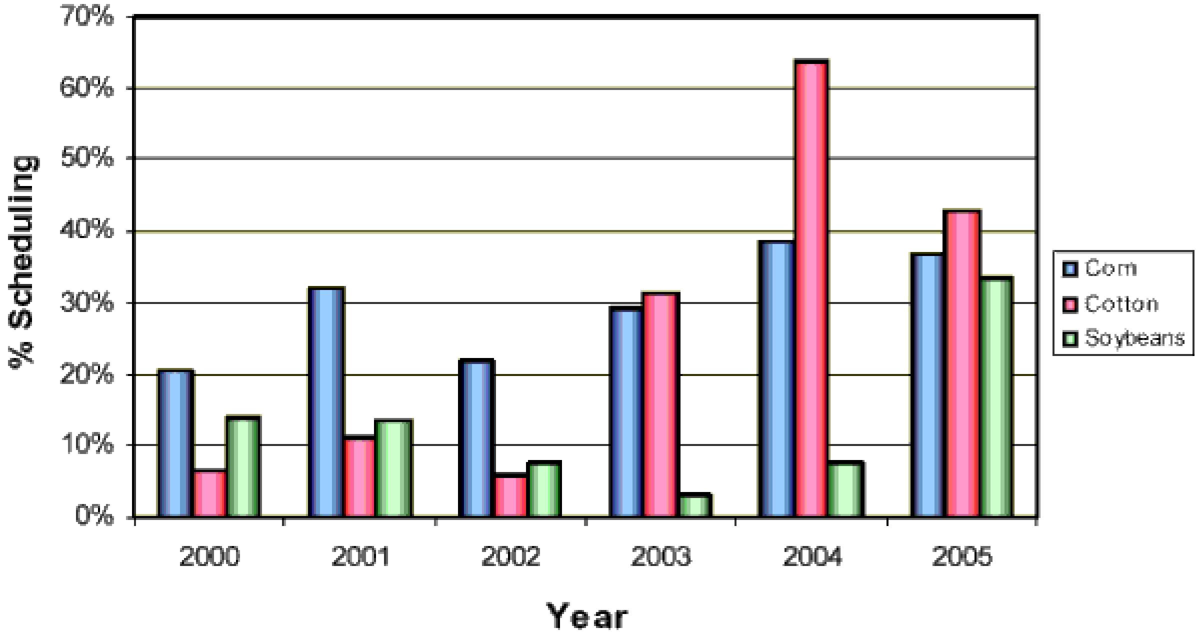

Fig. 3 - Percentage of farmers using irrigation scheduling by crop, southeast Missouri region, 2000-2005.

2. Surge Flow. Nearly 1 out of 4 furrow irrigated field in southeast Missouri makes use of surge flow. Cotton flood irrigators used the most surge (37% of the fields), with the other crops having a use rate of 20-25%. Surge flow fields have higher yields then do regular furrow irrigated fields for corn, cotton, and full-season soybeans. The increase in gross profits is highest for cotton, which has almost a $100/ac increase. Fields using surge flow get about 2 more irrigation applications then do regularly irrigated fields, except in the case of cotton, where seasonal application numbers for the two methods were nearly equally. The yields for surge and non-surge furrow irrigation, differences in gross profits, and differences in the numbers of seasonal irrigations for these crops are shown in Table 4.

Table 4. Surge versus non-Surge Yields, Yield Differences, Differences in Gross Profits, and Additional Number of Irrigations Applied with Surge for Various Crops, southeast Missouri region, 1997-2005

	Yield		Yield Difference	% Increase from Surge	Gross Profit Differences from Surge [a]	Additional # of Irrigations Applied with Surge
	Surge	No Surge				
Corn	179.2 bu/ac n = 30	167.9 bu/ac n = 124	11.4 bu/ac	6.8 %	$31.35/ac	2.2
Cotton	993.0 lbs/ac n = 32	850.0 lbs/ac n = 54	143.0 lbs/ac	16.8 %	$92.95/ac	-0.1

[a] *Gross profits based on corn at $2.75/bu, cotton at $0.65/lb, and soybeans at $5.50/bu. Differences in irrigation costs not included.*

3. Corn Yield as Affected by Type of Pivot. Corn was the only crop to show any significant difference in yields based on whether the pivot used was a fixed pivot or a towable one. The fixed pivot had a 12.6 bu/ac increase in yield over the towable one. The irrigation depth applied, number of seasonal irrigations, and total irrigation applied was similar for both types of pivots. Table 5 shows yields for fixed versus towable pivots, yield differences, and differences in gross profits for the southeast Missouri region, 1997-2005.

Table 5. Corn Yield for Fixed versus Towable Pivots, Yield Differences, and Differences in Gross Profits, southeast Missouri region, 1997-2005

	Yield		Yield Difference	% Increase from Fixed Pivot	Gross Profit Differences for Fixed Pivot [a]
	Fixed Pivot	Towable Pivot			
Corn	169.5 bu/ac n = 120	156.9 bu/ac n = 20	16.6 bu/ac	8.0%	$34.65/ac

[a] *Gross profits based on corn at $2.75/bu.*

4. Soybean Yield as Affected by Method of Irrigation. Soybeans, both full-season and double crop, were the only crop to show any significant difference in yields based on whether furrow irrigation or pivot irrigation was employed. For both types of soybeans, furrow irrigation increased yield by about 5 ½ bu/acre or $30 per acre. Table 6 shows yields for furrow versus pivot, yield differences, and differences in gross profits for full-season and double-crop soybeans in the southeast Missouri region, 1997-2005. It is important to note that it may not be the method of irrigation that is significant, but instead the fact that furrow-irrigated soybeans are planted on a bed. Two things point to this. First, when pivot yield data is broken down further and split up into "bedded" or "flat" we find that the pivot-irrigated, full-season soybeans with beds averaged 47.0 bu/acre, whereas the pivot-irrigated, flat-planted soybeans yielded 41.6 bu/acre, which is similar to the results shown in Table 6. Secondly, when data is broken down as to whether fields were laser-leveled or not laser-leveled , we again see there is a large difference. For full-season soybeans the yield difference is over 7 bu/acre (17.6%) higher when laser-leveled. The difference in yield for (1) flood versus pivot, (2) bedded versus flat, and (3) lasered versus not-lasered collectively point to the fact that surface drainage is the prime factor in yield differences.

Table 6. Full-season and Double-crop Soybean Yield for Furrow versus Pivot, Yield Differences, and Differences in Gross Profits, southeast Missouri region, 1997-2005

	Yield		Yield Difference	% Increase from Furrow	Gross Profit Differences for Furrow [a]
	Furrow	Pivot			
Full-season Soybeans	47.0 bu/ac n = 122	41.6 bu/ac n = 81	5.4 bu/ac	13.0%	$29.70/ac
Double-crop Soybeans	43.9 bu/ac n = 35	41.6 bu/ac n = 81	5.6 bu/ac	14.6%	$30.80/ac

[a] *Gross profits based on soybeans at $5.50/bu.*

VI. Farming Practices Affecting Yield

1. Fertigation. Fertigating appears to increase the yield for corn irrigators using pivots by about 10 bu/acre. Data on yield for fertigated versus non-fertigated corn fields, yield differences, percent increase, and differences in gross profits for the southeast Missouri region is seen in Table 7.

Table 7. Corn Yield for Fertigated versus non-fertigated Pivot Fields, Yield Differences, and Differences in Gross Profits, southeast Missouri region, 2001-2005

	Yield		Yield Difference	% Increase from Fertigating	Gross Profit Differences for Fertigating [a]
	Fertigated	Non-fertigated			
Corn	182.8 bu/ac n = 28	172.9 bu/ac n = 52	9.9 bu/ac	5.7%	$27.31/ac

[a] *Gross profits based on corn at $2.75/bu.*

2. Planting Date

A. Cotton. Yield and planting data from 87 cotton fields for the period 2001-2005 were used to generate the graph shown in Figure 4. Planting dates in the survey occurred as early as March 31st and as late as June 6th. About 60% of the fields in the survey were planted by May 1. The average yield for all fields planted on any one date was used. The plotted data are 3-day time averages used to take the bounce out of the data set. Planting either too early or too late appears to be detrimental to yield. The data suggests that, on average, planting too early subjects a field to a 23 lb/acre per day loss for dates prior to April 15. However, planting beyond the safe time range (after May 15) is actually worse, and yield drops about 30 lbs/ac per day after this point.

These results are similar to replicated planting date trials that were conducted for six years at the University of Missouri Delta Center in Portageville. Their conclusions were that, on average, a May 8th planting gave the best yields and that plantings done in late May/early June gave the worst results.

B. Corn. Yield and planting data from 166 corn fields for the period 2001-2005 were used to generate the graph shown in Figure 5. Planting dates in the survey occurred as early as February 29th and as late as June 9th. The plotted data are 3-day time averages used to take the bounce out of the data set. Unlike cotton, the early planting dates did not seem to reduce yield. However, planting after the first week of May appears to reduce yield by about 1 ½ bu/acre/day.

C. Soybean. Full-season and double-crop soybeans were grouped together for this analysis. Yield and planting data from 171 soybean fields for the period 2001-2005 were used to generate the graph shown in Figure 6. Planting dates in the survey occurred as early as March 29th and as late as July 18th. Like cotton, planting soybeans either too early or too late appeared to affect yield. The average yield for all fields planted on any one date was used. The plotted data are 5-day time averages used to take the bounce out of the data set.

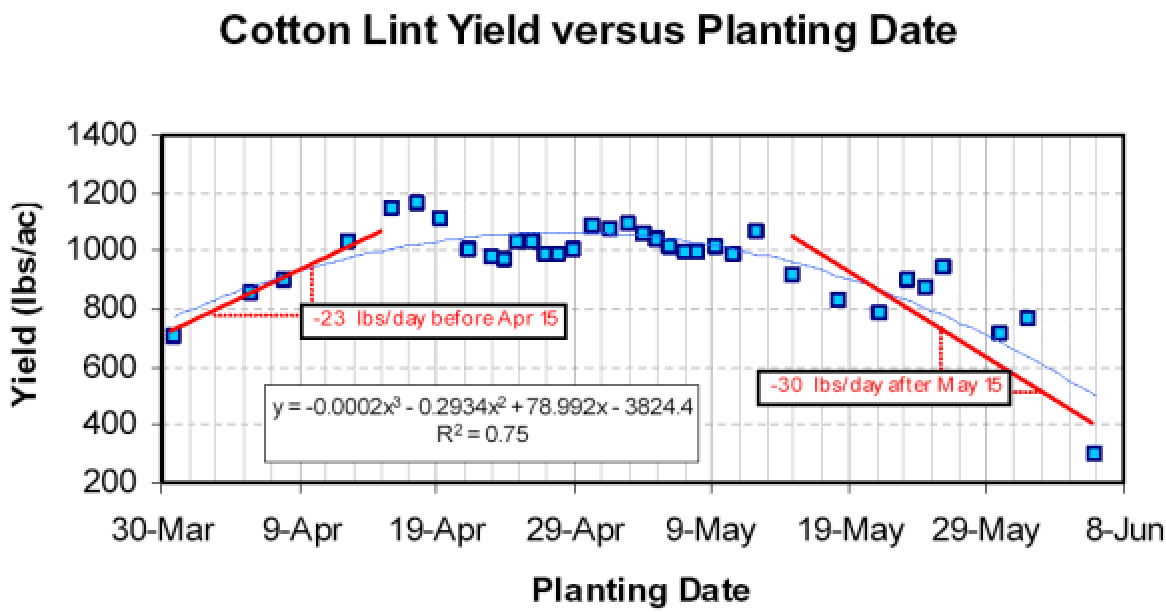

Fig. 4. Cotton lint yield versus planting date for Bootheel region of Missouri from Bootheel Irrigation Survey, 2001 to 2005. Yield values are 3-day time averages.

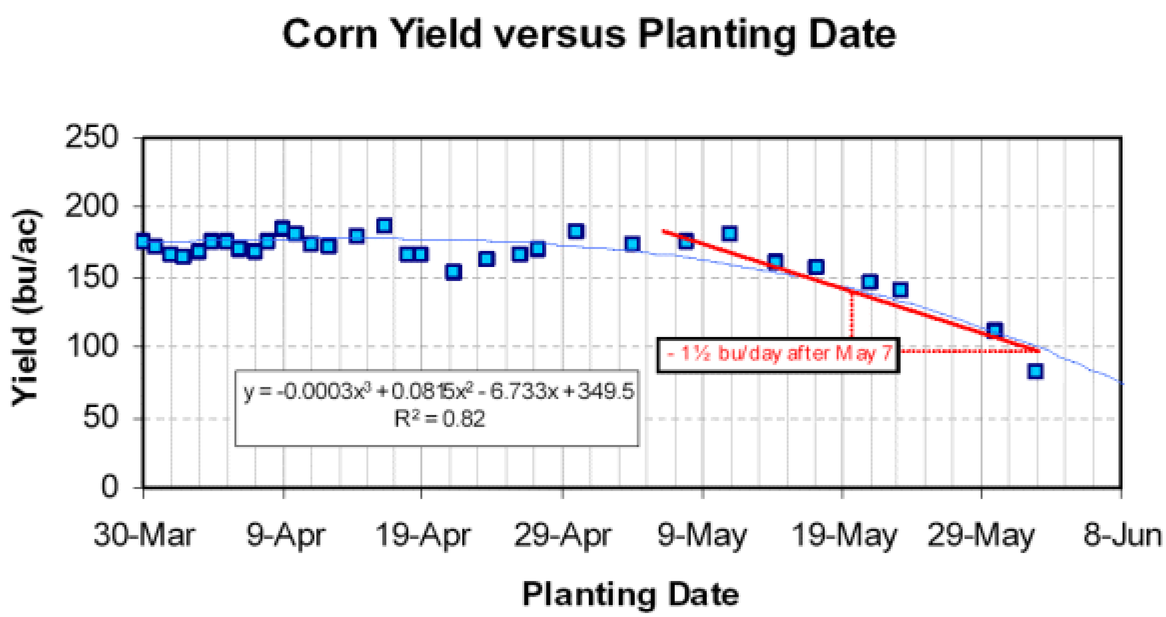

Fig. 5. Corn yield versus planting date for Bootheel region of Missouri from Bootheel Irrigation Survey, 2001 to 2005. Yield values are 3-day time averages.

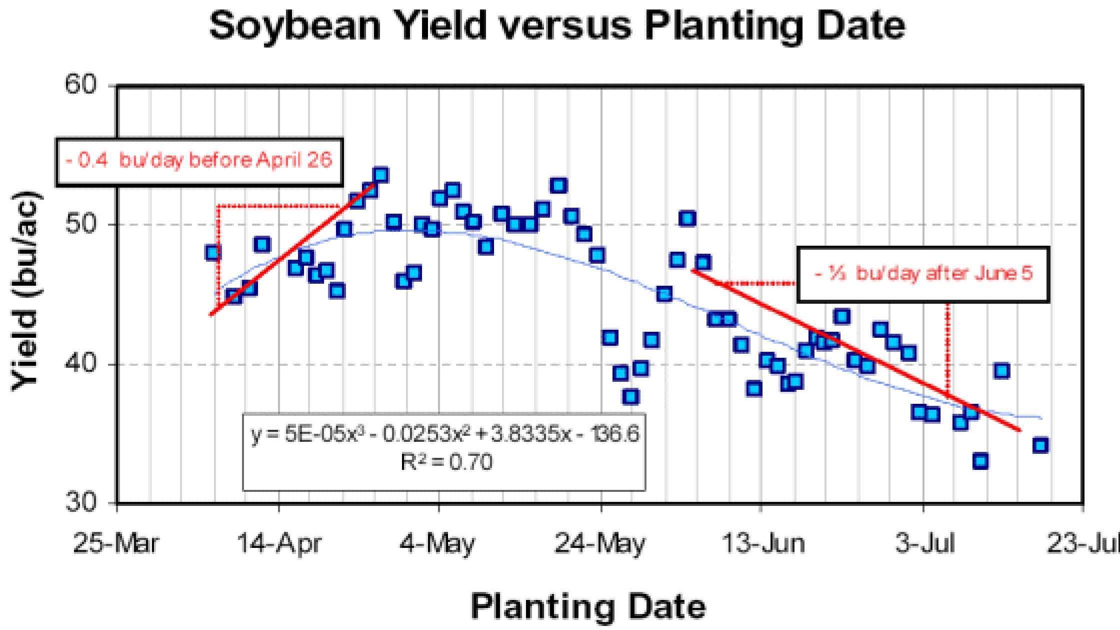

Fig. 6. Soybean yield versus planting date for Bootheel region of Missouri from Bootheel Irrigation Survey, 2001 to 2005. Yield values are 5-day time averages.

The data suggests that, on average, planting too early (i.e., before April 26) provides no yield increase and, in fact, may decrease yield by 0.4 bu/acre per day for dates earlier than April 26. Nearly a quarter to a third of soybeans in the region is double-crop soybeans, so by nature they have later planting dates. The yield difference between full-season and double-crop soybeans for the period 1997-2005 is 4.7 bu/acre. Overall, yields do not appear to drop from late-planting until June 5 is passed. At that point yields decrease ? bu/ac per day after that.

It should be noted that factors other then the actual planting date are in play in determining final soybean yield. The Maturity Group (MG) of the soybean does effect yield, and the MG used varies with the season. At this time, there are not enough data points in the survey to attempt to segregated yield as a function of both planting date and MG.

3. Relative Maturity

Relative Maturity (RM) appears to have impact on corn yield. Figure 7a shows yield versus RM value from 96 corn growers in the southeast Missouri region who responded in the years 2001 to 2005. Sliding averages have been used to take the bounce out of the data. It may appear that yields top out with RM values in the 113- to 115-day range. This is similar to information that retired ARS scientist, Larry Heatherly, compiled from recent mid-South variety trials. Heatherly indicated that medium-season hybrids (114-116 RM) were more consistent, and normally were better yielders then were the early- or late-season hybrids.

However, when RM versus yield is plotted by year for the irrigated corn hybrid trials conducted by the University of Missouri Variety Testing program for 2004-2006 (Fig. 7b) the results appear to indicate, in at least two of the three years (2005 was an inconsistent corn year), that yields increase linearly up to RM = 118. The values used in Figure 7b are the mean values for all hybrids having a similar RM value from the different test locations done each year (two or three locations depending on the year).

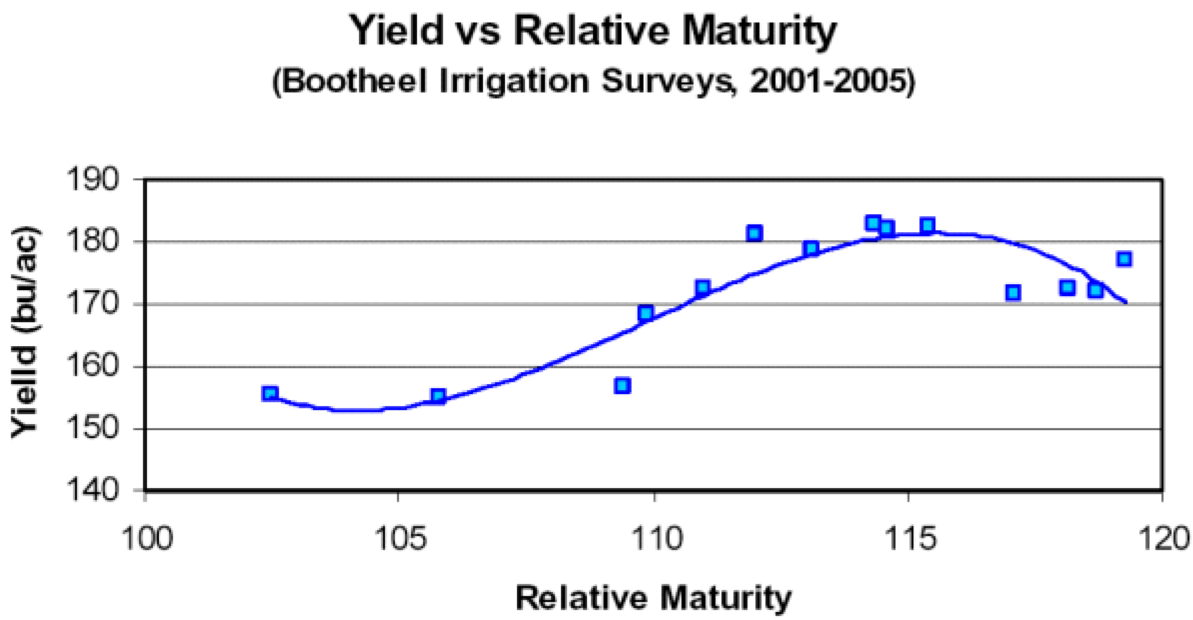

Fig. 7a. Corn Yield versus Relative Maturity as indicated by respondents of the Bootheel Irrigation Survey, 2001 to 2005. Sliding averages are used.

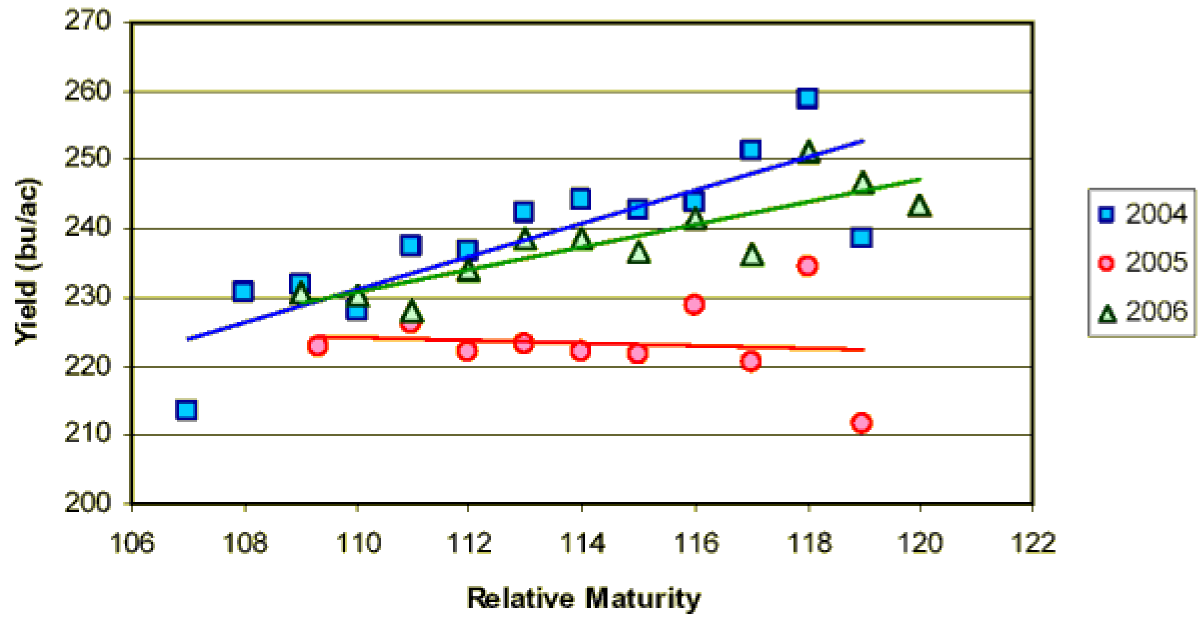

Fig. 7b. Corn Yield versus Relative Maturity from hybrids tested by the University of Missouri Variety Testing program in southeast Missouri, 2004-2006.

Caveat: There are only a few hybrids entered into the MU variety trials having high RM values (>117). Therefore, should just one do poorly then the average of the whole RM group is impacted. Secondly, all hybrids entered into a variety test must be treated similarly. This may lead to irrigation being cut-off too early on high RM hybrids if the majority of entries in the trial have reached black layer and do not need more irrigation. It should be pointed out that 7 out of 10 of the top Missouri yields in the irrigated class of the National Corn Growers Association (NCGA) yield championships had RMs of 117 or greater. The Missouri has produced 6 NCGA national champions in the various irrigated classes in the last two years (5 in 2006 and 1 in 2005) and four out of six of these national champions had RMs of either 118 or 119.

There are two take-home messages that can be derived from figures 7a and 7b. The first is that hybrids with really short RM values should probably be avoided; all data sets agree on this. Secondly, there is some indication that high RM hybrids may not being watered long enough in the season. The hybrids with RM values of around 113 to 115 did do the best in the respondent's survey. However, this appears to contradict the replicated MU variety trials which seem to indicate that the yield envelope can probably be pushed with RMs up to 118. Furthermore, under excellent management we know that local farmers have had superior yields with hybrids having RMs of 119. These longer varieties might require another inch and a half of water, so one should not short final yield by cutting off water too soon. Watering should continue until at least the ½ milk line stage is reached. When growing these long-season hybrids it may be wise to collect data on test weight, since this reflects late-season moisture management.

4. Bedding Up

In 2003 information on planting flat versus planting on a bed (small or high bed) was begun being collected. Since sample response was small, small bed and high bed data was pulled together as "bed". There was little yield difference between flat and bed on corn. However, cotton and soybeans (both full-season and double-crop) showed yield increases when planting on a bed. Table 8 shows data on yield for flat- versus bed-planted cotton, full-season, and double-crop soybeans, yield differences, percent increase, and differences in gross profits for the southeast Missouri region.

Table 8. Flat- versus Bed-Planted Yields, Yield Differences, and Differences in Gross Profits for Various Crops, southeast Missouri region, 2003-2005

	Yield		Yield Difference	% Increase from Beds	Gross Profit Differences from Bed-Planting [a]
	Bed-Planted	**Flat-Planted**			
Corn	1117.7 lbs/ac n = 37	887.5 lbs/ac n = 4	230.2 lbs/ac	25.9 %	$ 149.63/ac
Full-season Soybeans	51.9 bu/ac n = 13	47.6 bu/ac n = 24	4.3 bu/ac	9.1 %	$ 23.65/ac
Double-crop Soybeans	47.6 bu/ac n = 9	41.7 bu/ac n = 15	5.8 bu/ac	13.9 %	$ 31.90/ac

[a] *Gross profits based on cotton at $0.65/lb and soybeans at $5.50/bu.*

5. Laser Leveling

Laser-leveling is popular and has been increasing over time as shown in Figure 8. The vast majority of surface-irrigated fields in the southeast Missouri region have been laser leveled. Data indicates that today around 80% of these fields are so treated. Even pivot-irrigated fields are often laser-leveled. Data from the survey shows levels at about 20%. However, other sources show that this could be as high as 33% and that about 5-10% of dryland fields have been laser leveled.

There appears to be a yield increase associated with lasering for the same crops that responded to bed-planting (i.e., cotton and soybeans [both full-season and double-crop]). Table 9 shows data on yield for lasered- versus non-lasered cotton, full-season, and double-crop soybeans, yield differences, percent increase, and differences in gross profits for the southeast Missouri region. The fact that there is a similar response to beds and to lasering may indicate the importance of controlling surface drainage problems in southeast Missouri. Corn may not respond to either bedding up or lasering because it is often planted on well-drained soils.

Table 9. Laser Leveled- versus Non-Laser Leveled Yields, Yield Differences, and Differences in Gross Profits for Various Crops, southeast Missouri region, 1998-2005

	Yield		Yield Difference	% Increase from Lasering	Gross Profit Differences from [a]
		Not			

	Lasered	Lasered			Lasering
Cotton	919.2 lbs/ac n = 74	850.1 lbs/ac n = 81	69.1 lbs/ac	8.1 %	$44.92/ac
Full-season Soybeans	48.2 bu/ac n = 112	41.0 bu/ac n = 93	7.2 bu/ac	17.5 %	$39.60/ac
Double-crop Soybeans	41.8 bu/ac n = 33	39.6 bu/ac n = 73	2.2 bu/ac	5.6 %	$12.10/ac

[a]*Gross profits based on cotton at $0.65/lb and soybeans at $5.50/bu.*

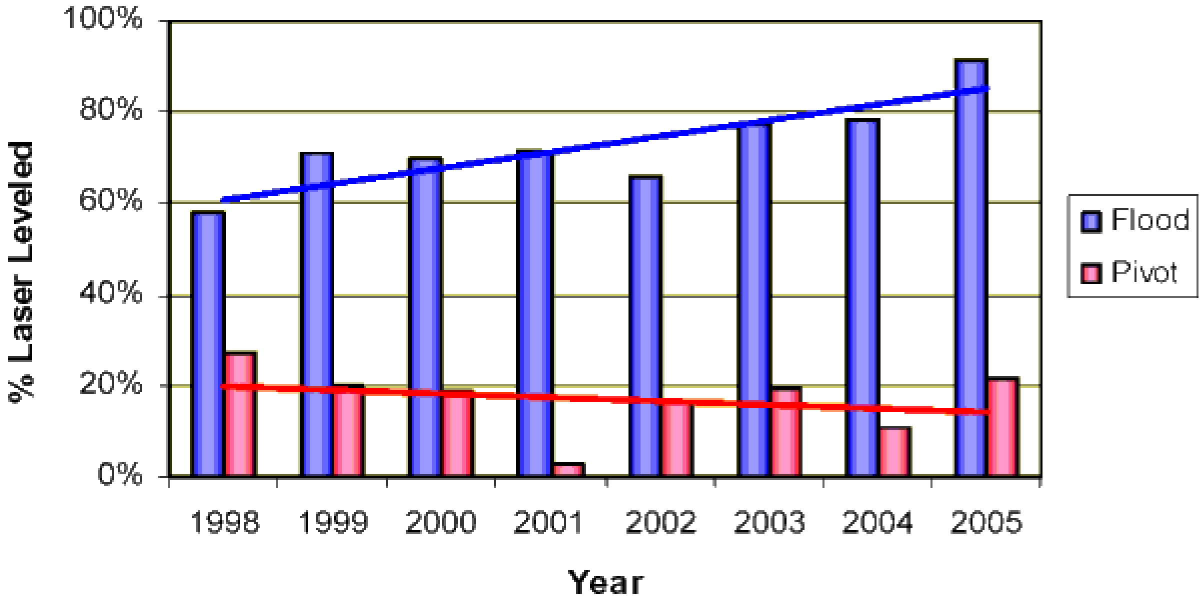

Fig. 8. Percentage of fields laser-leveled for flood- and pivot-irrigated fields in southeast Missouri region, 1998-2005.

Table 10. CORN yield in bushels per acre for various soil types as affected by minimum tilling, deep ripping, liming, and lasering, southeast Missouri region, 1998-2005 [a].

	Minimum Till		Deep Ripped		Limed		Lasered	
	Yes	No	Yes	No	Yes	No	Yes	No
Clay/gumbo	173.0 n = 27	166.9 n = 19	167.2 n = 13	166.6 n = 8	171.6 n = 26	161.0 n = 26	157.8 n = 29	177.0 n = 23
Sand	174.6 n = 43	173.6 n = 52	170.8 n = 82	161.8 n = 29	167.4 n = 29	171.2 n = 32	175.6 n = 34	165.3 n = 77
Silt	176.5 n = 49	175.2 n = 43	172.3 n = 72	169.8 n = 52	170.5 n = 65	172.1 n = 58	173.8 n = 59	169.0 n = 64
Other	157.5 n = 8	201.0 n = 2	163.0 n = 6	179.0 n = 8	179.0 n = 8	143.3 n = 3	154.7 n = 6	186.8 n = 5
AVERAGE	173.9 n = 127	173.6 n = 116	171.3 n = 171	166.4 n = 126	170.6 n = 128	168.7 n = 119	169.8 n = 128	168.9 n = 169
AVERAGE YIELD CHANGE	+ 0.4		+ 4.9		+ 1.9		+ 0.8	

[a] *Starting period for collecting various data was 1998, except for minimum till data which was started in 2000.*

Table 11. COTTON yield in lbs of lint per acre for various soil types as affected by minimum tilling, deep ripping, liming, and lasering, southeast Missouri region, 1998-2005 [a].

	Minimum Till		Deep Ripped		Limed		Lasered	
	Yes	No	Yes	No	Yes	No	Yes	No

Clay/gumbo	940.7 n = 8	772.4 n = 5	992.3 n = 7	680.8 n = 8	1013.0 n = 5	745.8 n = 10	895.2 n = 6	808.6 n = 9
Sand	978.7 n = 53	851.8 n = 8	885.4 n = 56	997.6 n = 25	897.3 n = 49	899.3 n = 32	947.7 n = 37	855.4 n = 44
Silt	950.1 n = 26	710.6 n = 7	748.7 n = 27	971.5 n = 19	874.2 n = 28	788.7 n = 18	886.7 n = 27	775.4 n = 19
Other	1003.4 n = 7	958.3 n = 6	1004.0 n = 11	865.2 n = 2	1044.4 n = 10	776.7 n = 3	911.0 n = 4	1014.4 n = 9
AVERAGE	969.44 n = 94	823.1 n = 26	869.2 n = 101	936.6 n = 54	912.6 n = 92	837.5 n = 63	919.2 n = 74	849.1 n = 81
AVERAGE YIELD CHANGE	+ 146.3		- 67.4		+ 75.1		+ 70.1	

[a] *Starting period for collecting various data was 1998, except for minimum till data which was started in 2000.*

Table 12. FULL-SEASON SOYBEAN yield in bushels per acre for various soil types as affected by minimum tilling, deep ripping, liming, and lasering, southeast Missouri region, 1998-2005 [a].

	Minimum Till		**Deep Ripped**		**Limed**		**Lasered**	
	Yes	No	Yes	No	Yes	No	Yes	No
Clay/gumbo	44.6 n = 31	41.7 n = 21	44.7 n = 19	41.8 n = 52	45.4 n = 27	40.9 n = 44	45.1 n = 41	39.2 n = 30
Sand	45.2 n = 27	44.2 n = 16	43.1 n = 30	45.2 n = 23	42.6 n = 30	45.8 n = 23	48.8 n = 21	40.9 n = 32
Silt	48.6 n = 29	48.5 n = 27	46.7 n = 25	48.9 n = 43	51.0 n = 33	45.3 n = 35	50.9 n = 44	43.0 n = 24
Other	41.8 n = 4	46.0 n = 7	43.4 n = 7	46.0 n = 6	48.4 n = 7	40.2 n = 6	47.2 n = 6	42.4 n = 7
AVERAGE	45.9 n = 91	45.3 n = 71	44.6 n = 81	45.2 n = 124	46.7 n = 97	43.3 n = 108	48.2 n = 112	41.0 n = 93
AVERAGE YIELD CHANGE	+ 0.7		- 0.5		+ 3.3		+ 7.2	

[a] *Starting period for collecting various data was 1998, except for minimum till data which was started in 2000.*

Table 13. DOUBLE CROP SOYBEAN yield in bushels per acre for various soil types as affected by minimum tilling, deep ripping, liming, and lasering, southeast Missouri region, 1998-2005 [a].

	Minimum Till		**Deep Ripped**		**Limed**		**Lasered**	
	Yes	No	Yes	No	Yes	No	Yes	No
Clay/gumbo	32.9 n = 10	45.5 n = 8	41.3 n = 4	38.2 n = 17	39.2 n = 5	38.6 n = 16	39.5 n = 8	38.3 n = 13
Sand	37.8 n = 20	42.0 n = 9	39.5 n = 26	39.6 n = 13	40.5 n = 28	37.0 n = 11	45.0 n = 11	37.4 n = 28
Silt	42.3 n = 19	38.9 n = 8	40.2 n = 19	43.7 n = 17	43.8 n = 17	40.2 n = 19	42.3 n = 12	41.6 n = 24
Other	44.7 n = 7	31.3 n = 3	45.3 n = 4	37.7 n = 6	38.5 n = 4	42.2 n = 6	30.0 n = 2	43.4 n = 8
AVERAGE	39.3 n = 56	41.0 n = 28	40.3 n = 53	40.3 n = 53	41.3 n = 54	39.3 n = 52	41.8 n = 33	39.6 n = 73
AVERAGE YIELD CHANGE	- 1.7		+ 0.1		+ 2.0		+ 2.2	

[a] *Starting period for collecting various data was 1998, except for minimum till data which was started in 2000.*

VIII. Historical Results of Bootheel Irrigation Survey Since 1987

TABLE 14. -- BOOTHEEL IRRIGATION SURVEY, 1987-2005
Yields for Irrigated and Dryland Crops

Year	Irrig. Corn (bu)	Non-Irrig. Corn (bu)	Irrig. Soybeans (bu)	Non-Irrig. Soybeans (bu)	Irrig. DC Soybeans (bu)	Non-Irrig. DC Soybeans (bu)	Irrig. Cotton (lbs)	Non-Irrig. Cotton (lbs)	Irrig. Milo (bu)	Non-Irrig. Milo (bu)
1987	149	121	44	32	33	19	---	---	110	101
1988	148	88	39	32	36	27	877	718	108	91
1989	152	117	37	27	29	23	807	605	92	77
1990	146	86	44	29	38	31	768	528	82	32
1991	143	84	42	29	43	30	917	678	105	69
1992	189	135	48	37	44	32	1029	990	121	108
1993	137	95	44	31	41	30	722	546	113	75
1994	162	123	47	38	43	37	933	779	101	93
1995	156	124	43	29	42	31	637	422	90	66
1996	170	124	43	32	42	25	905	719	98	63
1997	155	103	41	28	42	31	865	723	110	70
1998	140	95	37	22	40	27	692	542	82	---
1999	163	121	49	21	43	17	787	471	---	---
2000	171	---	43	---	39	---	733	---	140	---
2001	183	119	46	31	36	21	966	777	84	50
2002	160	104	45	28	43	30	873	686	114	63
2003	165	131	46	33	47	38	994	816	---	---
2004	184	150	51	33	43	37	1140	816	118	50
2005	180	141	49	36	44	28	1014	750	---	---
Avg	161	115	44	30	40	29	859	685	104	72

IX. Yield and Yield Differences and Surge Results by Soil Type and Irrigation Method

TABLE 15A.--IRRIGATED CORN YIELD
1997-2005 Bootheel Irrigation Survey
Showing yield (bu/ac), # of irrigations, Average Depth Applied (in), and sample size

Soil Type	Fixed Pivot	Tow-able Pivot	Rigid Pipe	Poly-pipe	Average
Sand	165.0 (10.5@ 0.9") n = 59	153.0 (9.7@ 0.9") n = 7	182.0 (6.5@ 1.5") n = 2	175.5 (5.4 @ 2.0") n = 43	168.6 (8.4 @ 1.3") n = 111
Silt	171.6 (6.3@ 0.9") n = 40	148.4 (8.6@ 1.0") n = 8	176.1 (3.9 @ 2.6") n = 16	171.8 (4.9 @ 2.2") n = 58	170.8 (5.5 @ 1.7") n = 122
Clay/Gumbo	181.2 (5.4 @ 0.9") n = 16	171.3 (3.8 @ 0.8") n = 4	162.5 (4.3 @ 2.3") n = 6	156.2 (5.3 @ 2.4") n = 25	166.0 (5.1 @ 1.8") n = 51
Other	168.0 (7.2 @ 1.2") n = 5	196.0 (? @ ?") n = 1	200.0 (? @ ?") n = 1	156.2 (5.5@ 2.6") n = 4	169.2 (5.6 @ 1.8") n = 11
Average	169.5 (8.3 @ 0.9") n = 120	157.0 (8.0 @ 0.9") n = 20	174.3 (4.2 @ 2.4") n = 25	169.5 (5.1 @ 2.2") n = 130	169.1 (6.5 @ 1.6") n = 295

Table 15b.—Comparing Use of Surge Flow on Corn Production among Flood Irrigators

1997-2005 Bootheel Irrigation Survey

	with SURGE	without SURGE
Furrow users' Yield:	179.2 bu/ac (n = 30)	167.9 bu/ac (n = 124)
Number of irrigations:	6.7	4.6

TABLE 15C.-- YIELD INCREASE DUE TO IRRIGATION FOR CORN
1997-2005 Bootheel Irrigation Survey
Showing yield enhancement (bu/ac) and sample size

Soil Type	Fixed Pivot	Tow-able Pivot	Rigid Pipe	Poly-pipe	Average
Sand	53.9 n = 59	76.4 n = 7	27.0 n = 2	71.9 n = 43	61.8 n = 111
Silt	45.3 n = 40	61.4 n = 8	55.4 n = 16	48.8 n = 58	49.4 n = 122
Clay/Gumbo	34.3 n = 16	20.0 n = 4	30.8 n = 6	37.9 n = 25	34.5 n = 51
Other	62.5 n = 5	---	---	0.0 n = 4	28.4 n = 9
Average	48.8 n = 120	58.2 n = 19	35.4 n = 24	52.8 n = 130	50.7 n = 291

TABLE 16A.--IRRIGATED COTTON YIELD
1997-2005 Bootheel Irrigation Survey
Showing yield (lbs/ac, # of irrigations, Average Depth Applied (in), and sample size

Soil Type	Fixed Pivot	Tow-able Pivot	Rigid Pipe	Poly-pipe	Average
Sand	860.3 (5.1@ 1.1") n = 36	948.0 (3.8@ 1.0") n = 6	725.5 (3.0@ 1.0") n = 2	937.4 (4.1 @ 2.1") n = 37	898.7 (4.5 @ 1.5") n = 81
Silt	835.5 (4.7@ 0.8") n = 8	784.3 (3.8@ 1.2") n = 6	750.0 (1.5 @ 2.0") n = 2	859.5 (2.8 @ 2.4") n = 30	840.8 (3.2 @ 2.0") n = 46
Clay/Gumbo	793.0 (7.0 @ 0.9") n = 8	650.0 (2.0 @ 1.5") n = 1	---	937.4 (3.5 @ 2.1") n = 6	841.2 (5.3 @ 1.4") n = 15
Other	1040.0 (4.7 @ 0.9") n = 4	---	---	959.4 (2.5@ 2.1") n = 9	984.2 (3.2 @ 1.7") n = 13
Average	860.0 (5.3 @ 1.0") n = 56	849.5 (3.7 @ 1.1") n = 13	737.5 (2.3 @ 1.5") n = 4	911.3 (3.4 @ 2.2") n = 82	883.1 (4.1 @ 1.7") n = 155

Table 16b.—Comparing Use of Surge Flow on Cotton Production among Flood Irrigators
1997-2005 Bootheel Irrigation Survey

	with SURGE	without SURGE
Furrow users' Yield:	993.0 lbs/ac (n = 32)	850.0 lbs/ac (n = 54)
Number of irrigations:	3.3	3.4

TABLE 16C.-- YIELD INCREASE DUE TO IRRIGATION FOR COTTON
1997-2005 Bootheel Irrigation Survey
Showing yield enhancement (lbs/ac) and sample size

Soil Type	Fixed Pivot	Tow-able Pivot	Rigid Pipe	Poly-pipe	Average
Sand	147.0 n = 36	182.0 n = 6	-88.5 n = 2	199.9 n = 37	167.9 n = 81
	120.0	195.3	187.5	228.5	203.5

Silt	n = 8	n = 6	n = 2	n = 30	n = 46
Clay/Gumbo	50.5 n = 8	200.0 n = 1	---	355.3 n = 6	182.4 n = 15
Other	206.3 n = 4	---	---	153.7 n = 9	169.9 n = 13
Average	133.6 n = 56	189.5 n = 13	49.5 n = 4	216.7 n = 82	180.1 n = 155

TABLE 17A.--IRRIGATED FULL-SEASON SOYBEAN
1997-2005 Bootheel Irrigation Survey
Showing yield (bu/ac), # of irrigations, Average Depth Applied (in), and sample size

Soil Type	Fixed Pivot	Tow-able Pivot	Rigid Pipe	Poly-pipe	Average
Sand	42.2 (7.1@ 0.9") n = 26	33.0 (6.3@ 0.9") n = 4	53.0 (4.0@ 2.0") n = 1	47.8 (5.0 @ 2.1") n = 22	44.0 (6.1 @ 1.4") n = 53
Silt	45.3 (7.2@ 1.0") n = 12	43.0 (4.7@ 0.8") n = 6	48.7 (2.9 @ 2.6") n = 12	49.6 (4.2 @ 2.5") n = 38	48.1 (4.5 @ 2.1") n = 68
Clay/Gumbo	38.5 (4.6 @ 0.9") n = 19	44.0 (7.1 @ 0.8") n = 9	46.0 (3.5 @ 2.3") n = 6	43.8 (3.9 @ 3.2") n = 37	42.6 (4.5 @ 2.2") n = 71
Other	48.0 (8.5 @ 0.8") n = 2	39.7 (9.7@ 0.6") n = 3	---	43.3 (7.5@ 1.8") n = 6	43.2 (8.3 @ 1.3") n = 11
Average	41.8 (6.4 @ 0.9") n = 59	41.1 (6.7 @ 0.8") n = 22	48.0 (3.2 @ 2.5") n = 19	46.8 (4.5 @ 2.6") n = 103	44.8 (5.1 @ 1.9") n = 203

Table 17b.—Comparing Use of Surge Flow on F-S Soybean Production among Flood Irrigators
1997-2005 Bootheel Irrigation Survey

	with SURGE	without SURGE
Furrow users' Yield:	48.4 bu/ac (n = 22)	46.7 bu/ac (n = 100)
Number of irrigations:	6.0	3.9

TABLE 17C.-- YIELD INCREASE DUE TO IRRIGATION FOR FULL-SEASON SOYBEAN
1997-2005 Bootheel Irrigation Survey
Showing yield enhancement (bu/ac) and sample size

Soil Type	Fixed Pivot	Tow-able Pivot	Rigid Pipe	Poly-pipe	Average
Sand	16.3 n = 26	8.0 n = 4	28.0 n = 1	16.8 n = 22	16.1 n = 53
Silt	12.8 n = 12	14.0 n = 6	18.3 n = 12	21.1 n = 38	18.5 n = 68
Clay/Gumbo	14.5 n = 19	7.0 n = 9	18.5 n = 6	17.0 n = 37	15.2 n = 71
	25.5	25.0		6.0	14.7

Other	n = 2	n = 3	---	n = 6	n = 11
Average	15.3 n = 59	11.5 n = 22	18.9 n = 19	17.8 n = 103	16.5 n = 203

TABLE 18A.--IRRIGATED DOUBLE-CROP SOYBEANS
1997-2005 Bootheel Irrigation Survey
Showing yield (bu/ac), # of irrigations, Average Depth Applied (in), and sample size

Soil Type	Fixed Pivot	Tow-able Pivot	Rigid Pipe	Poly-pipe	Average
Sand	37.6 (9.5@ 0.8") n = 24	35.1 (4.1@ 0.9") n = 7	---	48.0 (5.4 @ 2.1") n = 8	39.3 (7.7 @ 1.1") n = 39
Silt	40.8 (7.0@ 0.8") n = 10	37.9 (6.0@ 0.9") n = 6	44.0 (2.6 @ 2.7") n = 5	42.8 (3.4 @ 2.7") n = 14	41.6 (4.7 @ 1.8") n = 35
Clay/Gumbo	35.7 (5.6 @ 1.1") n = 11	45.7 (5.0 @ 0.8") n = 3	45.0 (2.5 @ 3.5") n = 2	38.5 (3.8 @ 2.0") n = 4	38.7 (4.8 @ 1.4") n = 20
Other	39.6 (6.5 @ 1.1") n = 8	---	---	45.0 (4.0@ ? ") n = 2	40.7 (6.0 @ 0.9") n = 10
Average	38.1 (7.8 @ 0.9") n = 53	38.1 (5.0 @ 0.9") n = 16	44.4 (2.6 @ 2.9") n = 7	43.9 (4.0 @ 2.4") n = 28	40.1 (6.0 @ 1.4") n = 104

Table 18b.—Comparing Use of Surge Flow on D-C Soybean Production among Flood Irrigators
1997-2005 Bootheel Irrigation Survey

	with SURGE	without SURGE
Furrow users' Yield:	40.8 bu/ac (n = 9)	45.0 bu/ac (n = 26)
Number of irrigations:	6.4	2.8

TABLE 18B.-- YIELD INCREASE DUE TO IRRIGATION FOR DOUBLE-CROP SOYBEANS
1997-2005 Bootheel Irrigation Survey
Showing yield enhancement (bu/ac) and sample size

Soil Type	Fixed Pivot	Tow-able Pivot	Rigid Pipe	Poly-pipe	Average
Sand	16.1 n = 24	14.3 n = 7	---	14.5 n = 8	15.5 n = 39
Silt	13.0 n = 10	25.6 n = 6	15.0 n = 5	18.7 n = 14	17.7 n = 35
Clay/Gumbo	11.1 n = 11	15.7 n = 3	---	3.5 n = 4	9.2 n = 20
Other	16.7 n = 8	---	---	12.5 n = 2	15.8 n = 10

Average	14.6 n = 53	18.8 n = 16	15.0 n = 5	14.9 n = 28	15.1 n = 104

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