Comparison of Center Pivot Low Elevation Spray and Low Energy Precision Application of Irrigation on Cotton in the Texas Southern High Plains

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Abstract

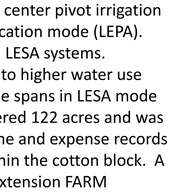
During the exceptional drought of 2011 and ongoing drought of 2012 an observational project was conducted on a Hale county cotton farm to determine the benefit of operating a center pivot irrigation system in the low elevation spray mode (LESA) versus low energy precision application mode (LEPA). LEPA systems are considered to have a 5% higher application efficiency rate than LESA systems. Therefore, the project sought to discover if the increase in efficiency would lead to higher water use efficiency and greater profitability. This was accomplished by running two of nine spans in LESA mode with the other seven spans in LEPA mode. The center pivot system studied covered 122 acres and was planted half in cotton and the other half in seed millet each year. Detailed income and expense records were maintained for both crops and for the two different irrigation methods within the cotton block. A long range strategic analysis comparison was run using the Texas A&M AgriLife Extension FARM Assistance model. The project demonstrated both higher water use efficiency, with an 15% higher lint yield per acre-inch of water pumped, and greater profitability of $123/acre for cotton irrigated with a LEPA system on average in 2011 through 2013. Long term projected analysis showed an average annual increase in net cash farm income of $6,710 for the entire system.

Introduction

The Ogallala aquifer has been declining in most areas of the Texas Southern High Plains and has reached critical drawdown levels in many. According to the 2012 Map of Center Pivot Locations within the High Plains Water Conservation District 12,971 center pivots were found irrigating 1,742,996 acres (HPWD, 2013) out of a total irrigated acreage of 2,176,824 (USDA-FSA, 2013), or 80%, and therefore offer the greatest potential for future water savings. The efficient use of irrigation resources is vital to the survival of area producers, so in September of 2004 the project "An Integrated Approach to Water Conservation for Agriculture in the Texas Southern High Plains" was approved by the Texas Water Development Board. This multidisciplinary and multi-entity demonstration project is run by a producer board, elected by producers in Hale and Floyd Counties with the purpose of encouraging research, demonstration, and implementation of practices to reduce water use while ensuring economic viability. The Texas A&M AgriLife Extension Service FARM Assistance program has collected income, expense, yield, and water use information from the demonstration sites each year from 2005 through 2013. During the exceptional drought of 2011, the ongoing drought of 2012 and the below average year of 2013 an observational project was conducted as a part of project on a Hale county cotton farm to determine the benefit of operating a center pivot irrigation system in the low elevation spray mode (LESA) versus low energy precision application mode (LEPA). LEPA systems are considered to have a 5% higher application efficiency rate than LESA systems (Water, 2004). Therefore, the project sought to discover if the increase in efficiency would lead to higher water use efficiency and greater profitability. This was accomplished by running two of nine spans in LESA mode with the other seven spans in LEPA mode. The project demonstrated both higher water use efficiency and greater profitability for cotton irrigated with a LEPA system in both 2011 and 2012.

Materials and Methods

The project site consisted of one 122-acre center pivot fed by two irrigation wells with a total capacity of 450 gallons per minute. On average, the farm was planted half to cotton and the other half to seed millet. Two of the nine pivot spans where run in the low elevation spray mode (LESA) and the remaining seven spans where run in the low energy precision application mode (LEPA). One module was made from the LESA spans and one module was made from the adjoining LEPA spans. The modules were weighed and ginned separately and the area from which they came was measured and recorded to obtain the yield per acre by irrigation method. The volume of water applied and all other operating costs were kept constant across both methods of irrigation.



Budgets were prepared for each year with all growing costs the same for both treatments. Harvest costs were calculated based on pounds of lint harvested and therefor were higher for the LEPA system due to the higher yields achieved. The average budget was used to build a 10-year simulation using the FARM Assistance model to determine the long-term consequences of each system.

Results

LEPA made higher yields than LESA on the same water and inputs in all three years studied (2011-2013), resulting in higher net returns and higher water use efficiency (Tables 1-4.)

Table 1. LEPA vs. LESA Budget Comparison 2011

	2011			
	LEPA		LESA	
PER ACRE GROSS INCOME	Quantity	Total	Quantity	Total
Cotton lint	1001	$ 900.90	879	$ 791.10
Cotton seed	0.722	$ 245.39	0.634	$ 215.48
PER ACRE TOTAL GROSS INCOME		$ 1,146.29		$ 1,006.58
PER ACRE TOTAL OF ALL COST		$ 968.89		$ 945.93
PER ACRE NET PROJECTED RETURNS		$ 177.40		$ 60.65
Percent Increase		193%		
WATER APPLIED - ACRE INCHES		26.1		
Lint Pounds per acre-inch of water applied		38.35		33.68
Percent Increase		13.9%		

Table 2. LEPA vs. LESA Budget Comparison 2012

	2012			
	LEPA		LESA	
PER ACRE GROSS INCOME	Quantity	Total	Quantity	Total
Cotton lint	1057	$ 951.30	896	$ 806.40
Cotton seed	0.762	$ 213.39	0.646	$ 180.88
PER ACRE TOTAL GROSS INCOME		$ 1,164.69		$ 987.28
PER ACRE TOTAL OF ALL COST		$ 980.33		$ 950.04
PER ACRE NET PROJECTED RETURNS		$ 184.35		$ 37.25
Percent Increase		395%		
WATER APPLIED - ACRE INCHES		19		
Lint Pounds per acre-inch of water applied		55.63		47.16
Percent Increase		18.0%		

Table 3. LEPA vs. LESA Budget Comparison 2013

	2013			
	LEPA		LESA	
PER ACRE GROSS INCOME	Quantity	Total	Quantity	Total
Cotton lint	1165	$ 873.75	1028	$ 771.00
Cotton seed	0.840	$ 235.19	0.741	$ 207.53
PER ACRE TOTAL GROSS INCOME		$ 1,108.94		$ 978.53
PER ACRE TOTAL OF ALL COST		$ 924.94		$ 906.33
PER ACRE NET PROJECTED RETURNS		$ 184.00		$ 72.20
Percent Increase		155%		
WATER APPLIED - ACRE INCHES		16.5		
Lint Pounds per acre-inch of water applied		70.61		62.30
Percent Increase		13.3%		

Table 4. LEPA vs. LESA Average Budget Comparison 2011-2013

	2011-2013							
	LEPA				LESA			
PER ACRE GROSS INCOME	Quantity	Unit	$/Unit	Total	Quantity	Unit	$/Unit	Total
Cotton lint	1074.3	lbs	$ 0.85	$ 913.18	934.3	lbs	$ 0.85	$ 794.18
Cotton seed	0.775	tons	$ 300.00	$ 232.38	0.674	tons	$ 300.00	$ 202.10
PER ACRE TOTAL GROSS INCOME				**$ 1,145.56**				**$ 996.28**
PER ACRE VARIABLE COST								
Boll Weevil Assessment				$ 1.00				$ 1.00
Fertilizer				$ 66.18				$ 66.18
Crop Insurance				$ 30.00				$ 30.00
Seed				$ 125.41				$ 125.41
Herbicide				$ 91.56				$ 91.56
Irrigation	20.5	ac. in.	$ 9.97	$ 204.39				$ 204.39
Field Operations				$ 47.19				$ 47.19
Harvest Aid				$ 35.14				$ 35.14
Strip, Module & Gin				$ 202.17				$ 175.83
Interest - OC capital (1/2 PRE-HARVEST)			7.00%	$ 19.80				$ 19.80
PER ACRE FIXED COST								
Irrigation - Pivot				$ 40.00				$ 40.00
Land				$ 100.00				$ 100.00
PER ACRE TOTAL OF ALL COST				**$ 962.83**				**$ 936.49**
PER ACRE NET PROJECTED RETURNS				**$ 182.73**				**$ 59.79**
Percent Increase				206%				
Lint Pounds per acre-inch of water applied				52.41				45.58
Percent Increase				15.0%				

Using the LEPA system, working capital was increased from $0 at the start of the analysis to $50,640, while the LESA system generated negative working capital in the amount of -$11,240. The probability that LESA would generate negative working capital ranged from44% to 61%, while LEPA ranged from 12% to 17% (Figure 1).

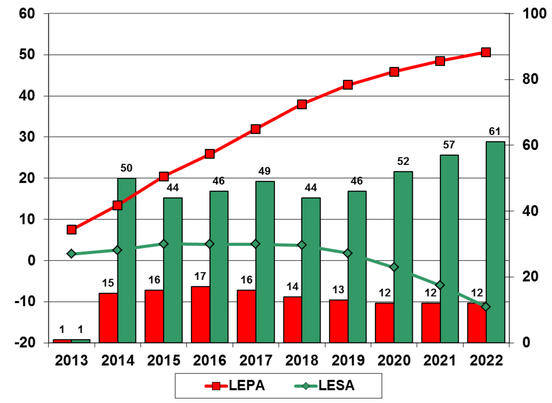


Figure 1. Working Capital and Probability of Negative Working Capital LEPA vs. LESA.

Given the current FARM Assistance baseline for future cotton prices this analysis projects an un-sustainable cotton operation using LESA when extended out over the 10-year period.

The LEPA system, however, is projected to continue to improve financial position and performance over the life of the analysis

Over the 10-year projection total cash receipts were considerably higher, while total cash costs were only slightly higher resulting in higher net cash farm income for LEPA versus LESA (Table 5).

Cumulative higher net returns resulted in LEPA having $43,020 higher ending cash after taxes by the end of the 10-year period.

The likelihood of the farm generating a net operating loss was reduced from 53.4% (LESA) to 39.7% (LEPA).

Table 5. LEPA vs LESA 10-yr FARM Assistance Analysis (61 acres)

	2013-2022 Average	
	LEPA	LESA
Total Cash Receipts ($1000)	67.94	59.67
Total Cash Costs ($1000)	62.04	60.48
Net Cash Farm Income ($1000)	5.90	-0.81
Average Annual Operating Expense/Receipts	0.97	1.06
Ending Cash Reserves ($1000)	57.43	14.41
Prob. Net Cash Income < Zero (%)	39.70	53.40

Summary

The project demonstrated both higher water use efficiency, with a 15% higher lint yield per acre-inch of water pumped, and greater profitability of $123/acre (206% increase) for cotton irrigated with a LEPA system on average in 2011 through 2013. Long term projected analysis of the 61 acres of cotton showed an average annual increase in net cash income of $6,710 and the accumulation of an additional $43,020 in after tax cash. The other half of the pivot was planted to seed millet all 3 years and no difference in yield was observed between treatments. Therefore, the additional net income was obtained with no additional costs. The only cost that would be incurred by a producer adopting this practice would be the cost of converting nozzles and equipment from LESA to LEPA if necessary.

References

Water Conservation Implementation Task Force. November 2004. BMP Guide, 4.3.3 Low Pressure Center Pivot Sprinkler Irrigation Systems.

High Plains Underground Water Conservation District. 2013. Reference Maps and Charts, http://hpwd.com/maps-and-charts/reference-maps-and-charts

USDA Farm Service Agency. 2012 Crop Acreage Data. January 2013, http://www.fsa.usda.gov/FSA/webapp?area=newsroom&subject=landing&topic=foi-er-fri-cad

The Texas Alliance for Water Conservation mission is to conserve water for future generations by collaborating to identify those agricultural production practices and technologies that, when integrated across farms and landscapes, will reduce the depletion of ground water while maintaining or improving agricultural production and economic opportunities.

The Texas Alliance for Water Conservation is a unique partnership of area producers, data collection technologies, and collaborating partners that includes industries, universities, and government agencies.

The project uses on-farm demonstrations of cropping and livestock systems to compare the production practices, technologies, and systems that can maintain individual farm profitability while improving water use efficiency with a goal of extending the life of the Ogallala Aquifer while maintaining the viability of local farms and communities.