The Profitability of Irrigating Corn in Tennessee: Implications of Field Size and Energy Costs

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BACKGROUND

- The Mid-South region of the U.S. receives sufficient annual rainfall to grow corn without irrigation in most years, but irrigation of corn is common because rainfall is not always timely for the crop (Vories et al., 2009).
- Rolling upland topography of western TN causes the corn fields to be smaller and more irregularly shaped than corns fields in the MS Delta.
- Thus, TN has the smallest percentage of irrigated corns acres than any other state in the Mid-South region (USDA-NASS, 2012).
- Investment in irrigation systems in western TN, however, has been increasing in recent years.
- Little is known about the breakeven corn price for investing in supplemental irrigation systems in TN.

OBJECTIVE

To determine the breakeven price of corn where investment in center-pivot irrigation would be profitable in TN.

FRAMEWORK & ESTIMATION

The producer's objective was

$$E(\pi) = E[py_{\gamma} - rN_{\gamma} + \gamma(cw + l + m)]$$

where $E(\pi)$ is the expected net return in \$/acre; γ is a binary variable that is γ=1 for irrigation and γ =0 for non-irrigation; p is the price of corn in \$/bu; y_{γ} is yield in bu/acre and is a function of the nitrogen (N) fertilizer rate N_{γ} in lb/acre; r is price of N fertilizer in \$/lb; c is the cost of energy for pumping water in \$/inch/acre; w is the irrigation water rate in inches/acre; l is the labor cost for monitoring soil water status and other labor activities related to irrigation in \$/acre; and m is irrigation maintenance and repair costs in \$/acre.

Cash flows were then calculated for irrigated and non-irrigated corn. To determine the breakeven corn price, we use the cash flows to calculate the net present value (NPV) of investing in an irrigation system and then solve for the corn price that makes NPV equal zero. The NPV equation was

$$\min_{p} NPV = -IC + \sum_{t=1}^{T} \frac{CF_{1t} - CF_{0t}}{(1+\tau)^t} = 0$$

where IC is the initial investment in irrigation equipment in year t=0; CF_{t1} is the cash flow for irrigated corn; CF_{t0} is the cash flow for non-irrigated corn; T=20 is the useful life of the irrigation equipment; and τ =0.08 is the risk-adjusted discount rate. The producer financed the cost of the well and system over five years at 5% interest, and the total capital investment cost was depreciated under the MACRS at a 25% marginal tax rate.

To avoid overstating the profitability of irrigation, we considered how the breakeven price of corn influenced optimal yield and N fertilization rates. Yield response to N fertilizer was estimated for irrigated and non-irrigated corn, and breakeven expected yields and fertilizer rates were estimated using Tembo et al.'s (2008) linear response stochastic plateau function.

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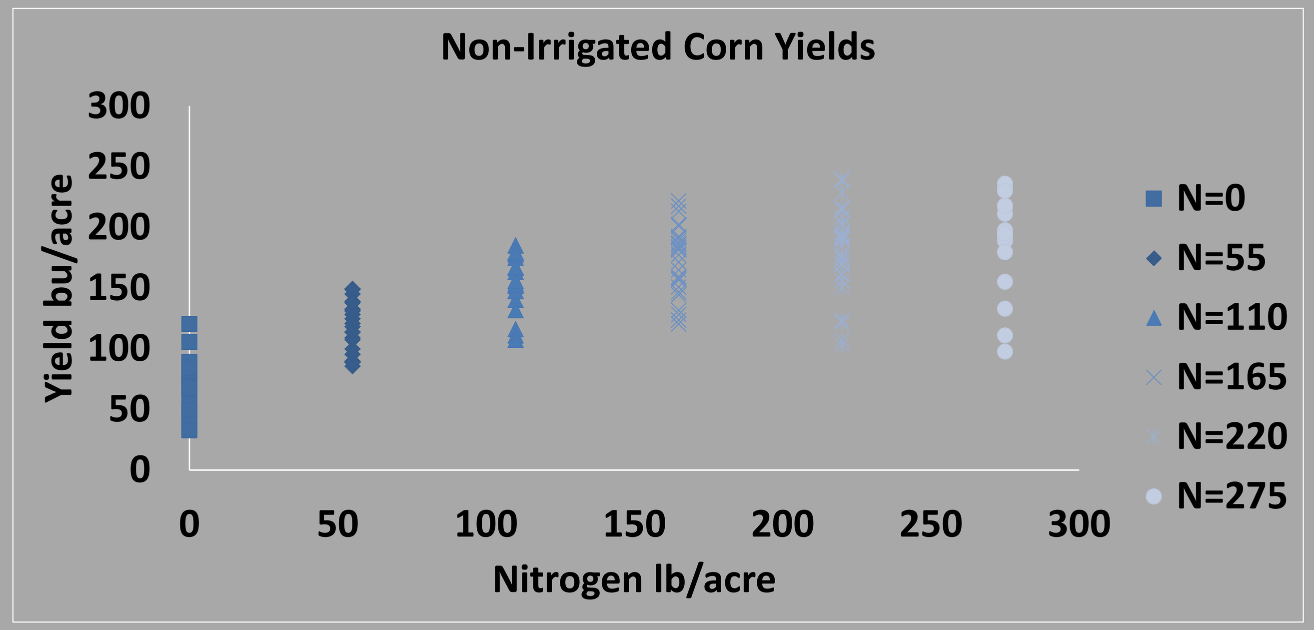
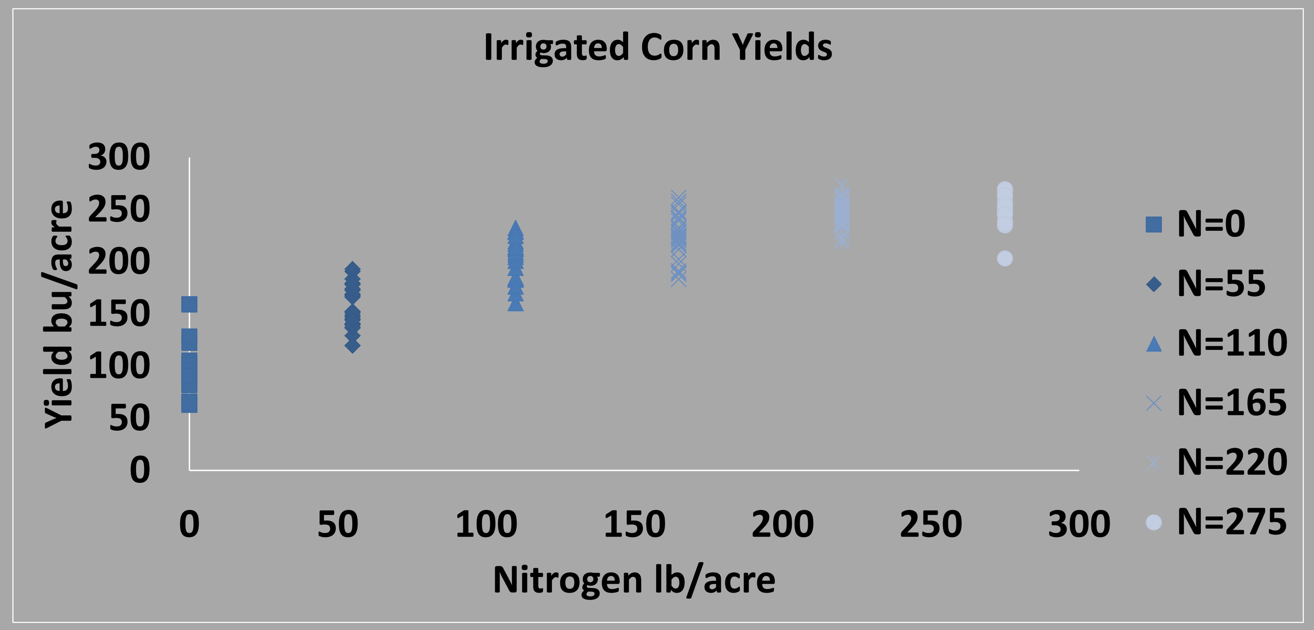
EXPERIMENT

- Corn yield data come from N fertilization experiments conducted at the Milan Research and Education Center at Milan, TN from 2006 to 2011.
- No-till irrigated and non-irrigated corn experiments were rotated with soybeans.
- The experimental design was a RCB with four replications and annual N rates of 0, 55, 110, 165, and 220 lb/acre in 2006 and 2007, and 275 lb/acre beginning in 2008.





INPUT & IRRIGATION COST DATA

The investment costs for a non-towable center-pivot system and energy costs were generalized from personal communications with a irrigation dealership in TN and an irrigation expert (Verbree 2012).

- System investment costs included well drilling, pump, power unit, and the irrigation rig and were \$106,700, \$135,300, and \$184,256 for a 60, 125, and 200 acre fields; respectively.
- Farm diesel prices of \$2, \$3, and \$4/gallon, and commercial electricity prices of \$0.07, \$0.09, and \$0.11/kWh were used.
- Three fixed costs of \$10,000, \$15,000 and \$20,000 were assumed for run electrical power to the center-pivot.
- Annual repair and maintenance costs was 1.7% of the investment costs.
- Annual irrigation labor cost was \$12/acre.
- An annual weighted average irrigation rate of 15.68 inch/acre was calculated using the actual irrigation data from the experiment.
- Nitrogen cost was \$0.6/lb.

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RESULTS

Table 1. Breakeven corn price (\$/bu) to invest in a center-pivot by energy source, energy cost, and field size.

Per-Unit Energy Costs	Field Size		
	60 acres	125 acres	200 acres
		Diesel Energy	
\$2/gallon	\$6.97	\$4.69	\$4.17
\$3/gallon	\$7.27	\$5.00	\$4.48
\$4/gallon	\$7.58	\$5.31	\$4.79
	Electric Energy with a \$10,000 Fixed Cost Investment		
\$0.07/kWh	\$7.19	\$4.64	\$4.02
\$0.09/kWh	\$7.28	\$4.73	\$4.11
\$0.11/kWh	\$7.38	\$4.82	\$4.20
	Electric Energy with a \$15,000 Fixed Cost Investment		
\$0.07/kWh	\$7.48	\$4.78	\$4.11
\$0.09/kWh	\$7.57	\$4.87	\$4.20
\$0.11/kWh	\$7.65	\$4.96	\$4.29
	Electric Energy with a \$20,000 Fixed Cost Investment		
\$0.07/kWh	\$7.76	\$4.92	\$4.19
\$0.09/kWh	\$7.85	\$5.00	\$4.28
\$0.11/kwh	\$7.94	\$5.09	\$4.37

KEY CONCLUSIONS

- Breakeven corn prices for investing in a center-pivot irrigation system ranged from \$4.02/bu to \$7.94/bu depending on the energy source and field size.
- N rates for the breakeven prices ranged from 178 to 188 lb/acre for irrigated corn and 143 to 161 lb/acre for non-irrigated corn.
- Expected yields for the breakeven prices ranged from 213 to 215 bu/acre for irrigated corn and 149 to 152 bu/acre for non-irrigated corn.
- As field size increased, electrical power became more economically viable relative to diesel.
- Future research is needed on the tradeoff between financial risk and production risk from irrigation investment.
- Implications of historically high corn prices on future water planning for agricultural water in TN needs to be addressed.
- At current corn prices, irrigating corn in TN is profitable; however, current corn prices are much higher than the historic average.

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