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Electricity Rates, Input Use and Irrigated Cotton Profitability: A Hedonic Versus Traditional Profit Maximization Approach

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ABSTRACT

The impact of increasing energy cost on the optimal level of nitrogen and irrigation water use is examined for two irrigated cotton production management strategies using LEPA irrigation. The first strategy is a traditional production management strategy where the optimal per acre application rate is the rate that maximizes expected profit based on a fixed expected cotton lint price and known lint yield response to applied nitrogen and irrigation water. Under the second production strategy, cotton producers are assumed to maximize a hedonic profit function that explicitly considers the tradeoff between lint yield and lint quality attributable to alternative nitrogen and irrigation application rates, and the net effect the tradeoff has on per acre profit. The hedonic production approach, which manages for both quality and quantity, was found to be the more profitable producer strategy and used less fertilizer and less irrigation water.

KEYWORDS: Hedonic profit function, cotton, energy cost, irrigation cost

Though the deregulation of the electric power industry in Texas promises lower electric prices for consumers in aggregate, a number of studies indicate deregulation may lead to higher prices in rural areas of the country due to the limited ability of many rural regions to import electricity from producers outside their region (Northcutt 2001, Johnson 1999, Chernoff and Sanchez 1998). Johnson (1999) estimated that 55% of all irrigated Texas High Plains (THP) farms use electricity as their power source. Higher electricity costs will increase the cost of lifting groundwater and pressurizing irrigation systems and decrease already slim farm profit margins for those producers utilizing electricity as their power source. This is especially critical to THP cotton producers, who farm 60% of all irrigated land in the THP, and are considering switching from natural gas to electric energy given that natural gas pumping cost has risen by nearly five-fold, in some areas of the THP, in the last two years (Lubbock Avalanche Journal June 1, 2003).

A common strategy for dealing with shrinking profit margins is to increase yields by increasing factor input use and/or altering the production technology. However, such strategies will not increase profits when the additional costs exceed the additional revenue generated by the yield enhancement strategy. Recent studies indicate a superior approach to increasing cotton profitability is to broaden management practices beyond yield considerations, and include quality considerations in identifying profit-maximizing input use regimes (Denning et al. 2002, Green et al. 1999, Morrow and Krieg 1990). But, the relative additional profitability gains, or potential losses from this broadened management perspective is unknown in the case of changing factor input prices.

This research examines the potential economic benefit that can be captured by cotton producers if they adjust their management practices from a yield focus to a joint yield and quality focus for purposes of mitigating expected increases in electric energy prices. We specifically examine how per acre gross revenue and selected irrigation related variable cost items optimally respond to potential increases in energy cost under two alternative management strategies. The first strategy assumes producers simultaneously manage for both lint yield and lint quality, whereas in the second management strategy producers are assumed to follow tradition and manage solely for lint yield, and ignore the impact yield optimizing use rates have on lint quality. We also examine the capacity of revenue premiums for increased lint quality to partially, or totally, offset yield-related revenue decreases that may occur under reduced irrigation application rates. The sensitivity of the results to climatic conditions is also examined.

DATA AND METHODS

The data used to estimate the impact of per acre water and fertilizer input levels on cotton quality attributes was collected by Allen and Krieg (2000) from three field experiments conducted in Lubbock County, Texas, in 1997, 1998 and 1999. This data set contained 1,033 paired observations on lint yield, seed yield, turnout, micronaire, staple length, and fiber strength values corresponding to varying irrigation water/nitrogen application rates, phosphorous fertilizer application methods and rates, seed varieties, and weather conditions (i.e. accumulated heat units and rainfall during the cotton growing season).

Supplemental irrigation water, applied through a LEPA system, ranged from 3 to 14 acre-inches. Nitrogen was applied through the irrigation system at a rate of 6 pounds per acre-inch of applied water as recommended by Morrow and Krieg (1990). Three different phosphorous application methods were evaluated: pre-plant, side-dress, and fertigation at rates ranging from 0 to 73 pounds per acre. All water/fertilization application combinations were repeated for eleven cottonseed varieties: Paymaster HS 26, Paymaster HS 200, Delta Pine 2156, Paymaster Tejas, HOL 101, HOL 338, All-Tex Atlas, AFD Explorer, AFD Rocket, All-Tex Toppick, and All-Tex Xpress.

Temperature and rainfall measurements were collected at the research site. The experiment received less-than-average rainfall (8.5 inches) and close-to-average heat unit accumulation (1161C) in 1997. In 1998, a dry year, the plots received little rainfall (5.4 inches) and a relatively high heat unit accumulation (1544C). During 1999, the experiment received below average heat unit accumulation (1022C) and rainfall (6.3 inches). Heat unit accumulations were calculated from daily temperature data during the THP cotton-growing season, which extends from May to September.

Cotton yield and lint quality attributes were measured at each experimental plot by hand harvesting all cotton bolls within a sample area of 1/1000 of an acre. The harvested bolls were ginned and a sample of the ginned cotton from each plot was sent to the International Textile Center of Texas Tech University to determine the values of its lint quality attributes. Staple length, strength, and micronaire were measured using High Volume Instrument (HVI) tests. A complete discussion of the empirical data is found in Allen and Krieg (2000).

Modeling Procedure. In prior research, Britt et al. **(**2002) used Allen and Kreig=s data set in an econometric analysis to estimate the impact irrigation application level, fertilization level, and climatic condition have on per acre cotton lint yield, and the seven lint quality attributes for which price premiums and discounts are applied. This study merges their estimated production relationships for cotton quality attributes with price estimates for yearly average lint price, and price premiums and discounts paid for specific cotton quality attributes. The price premium and discount values were estimated using the Daily Price Estimation System (DPES). The DPES is a computerized, econometrically based, price analysis system maintained and operated by the Department of Agricultural and Applied Economics at Texas Tech University. The DPES uses a hedonic modeling approach to statistically estimate the quality premium and discount values for the West Texas and East Texas/Oklahoma cotton marketing regions on a daily basis. In any given marketing year the DPES estimates daily and average annual premiums and discounts for seven lint quality attributes: (1) leaf grade, (2) color grade, (3) staple length, (4) strength, (5) micronaire, (6) bark, and (7) other extraneous matter. Price premiums are paid for attributes whose quality exceeds a specified baseline quality level, and price discounts are used to adjust base price downward for attributes that are below the baseline quality level. When each of the seven lint quality attributes is at their respective baseline value the producer receives the base price because no quality adjustment is made to the base price. The average premium or discount value associated with the level of each quality attribute as determined by the 1998 DPES marketing year equations is used in this analysis (Hoelscher et al. *1*999). The 1998 marketing year was selected because the average premium and discount values generated by the DPES equations in this marketing year are representative of the average premiums and discounts for the seven lint quality attributes over the 1993-2001 period and thus allow the empirical results to be interpreted as an expected average value for each scenario considered (Misra 2002).

Hedonic Optimization Framework. Nonlinear mathematical programming was used to determine both the input use levels that maximize per acre profit and to simulate the relationships between input use levels, lint yield, lint quality, and producer lint price. The objective function was specified to simultaneously consider the impact fertilizer and water application rates have on both lint yield and lint quality, for a specified seasonal weather pattern, in the maximization of per acre profit. Models that explicitly consider the influence of quality attributes on the market price of a commodity are commonly referred to as hedonic models. The optimization framework allows additional water and fertilizer to be applied when it is more profitable to manage for yield than quality, and less water and fertilizer is applied, on the margin, when it is more profitable to manage for quality than yield. The nonlinear lint yield and quality response equations estimated by Britt et al. (2002) are embedded in the optimization model constraint set and used to link water and fertilizer application rates to yield and yield quality attributes. The level of each quality attribute, for a specific input regime, is internally passed to the 1998 DPES equation, an average pricing year, to calculate the quality adjusted per pound price received by producers. Hence, the premium and discount estimates are non-linear functions of the lint quality attributes, which in turn are a nonlinear function of input use levels, seed variety, and weather conditions. Thus, the hedonic optimization model endogenously determines the water and fertilizer application rates that maximize per acre profit for a given cost structure, production function, and set of weather conditions. In conceptual terms, the mathematical structure of the hedonic optimization procedure can be viewed as an eight equation system:

(1) Max Profit = $P^H * Y^H$ - ERC - NERC

Where:

- P^H = per pound hedonic price, and is endogenously estimated using the following general functional form: F(micronaire, strength, staple| other quality attributes fixed at appropriate base attribute values),
- Y^H = is per acre hedonic lint yield,
- ERC = G(cost applied irrigation water, cost electricity used, cost liquid nitrogen used), and
- NERC = H(per acre cost of all fixed inputs and those variable inputs not in ERC).

Subject to:

(2) Y^H = I(water, liquid nitrogen, seed variety, heat units, rainfall | all other inputs fixed),

(3) Micronaire = J(water, liquid nitrogen, seed variety, heat units, rainfall | all other inputs fixed),

(4) Strength = K(water, liquid nitrogen, seed variety, heat units, rainfall | all other inputs fixed),

(5) Staple = L(water, liquid nitrogen, seed variety, heat units, rainfall | all other inputs fixed),

(6) $Water_x$ = M(electricity | given irrigation technology x),

(7) $Nitrogen_x$ = N(electricity | given irrigation technology x), and

(8) $Water_x$ # maximum acre-inch/per acre irrigation water applied using system x over the growing season.

Equation 1 is the objective, or profit, function that is to be maximized. Per acre profit is maximized when the difference between total revenue (TR) and the sum of electricity related variable costs (ERC) and non-electricity related costs (NERC) is as large as possible. In the hedonic model specification, per acre TR ($P^H * Y^H$) is calculated as the product of the endogenously determined per acre quantity of lint produced (Y^H) and the endogenously determined hedonic lint price (P^H). To isolate the impact changing electric rates are likely to have on cotton profitability, for a given irrigation technology, only those input cost items that vary with per acre energy use are allowed to vary in this analysis. Thus, ERC consists of the electricity expenditure required to apply the optimal per acre quantity of irrigated water, depreciation and maintenance of irrigation equipment used to deliver the optimal quantity of irrigation water, and the per unit cost of applying liquid nitrogen fertilizer at the optimal irrigation level. The application of liquid nitrogen fertilizer is treated as an electricity related variable cost because the experimental data which this analysis is based upon used fertigation to apply liquid nitrogen at a fixed rate per acre inch of applied irrigation water. NERC is defined as the per acre sum of all other variable cost items plus the traditional fixed cost items (machinery, irrigation system, land, etc.) and does not vary with the energy use level.

Constraint equations 2, 3, 4, and 5 capture the impact that changes in the per acre quantity of applied irrigation water, liquid nitrogen, heat units, and rainfall have on lint yield, measured in pounds, and the three most economically important qualitative lint attributes, micronaire, strength, and staple. The value of each of the three lint quality measures in combination with the 1998 base price endogenously determine the hedonic price per pound of lint

(P^H) and is the price variable in equation 1 (the profit function to be maximized). The four other lint quality attributes (leaf grade, color grade, bark, and other extraneous matter) are assumed to be at their respective base quality levels, the level for which no price discount is deducted nor a premium paid. The specific functional forms for equations 2, 3, 4, and 5 are reported in Britt et al. (2002).

Constraint equations 6 and 7 explicitly recognize that the quantity of irrigation water and nitrogen (liquid form) applied are a function of energy use. Consistent with the empirical data used to estimate the lint yield and lint quality response to applied water and nitrogen, the hedonic optimization model assumes fertigation is used to apply nitrogen to the crop. Equation 8 prevents the per acre quantity of applied irrigation water from exceeding the capacity of the irrigation system. The per-acre inch cost of applied water (C_W) is calculated as:

(9) C_W = Pumping Cost + Machinery Cost
= 0.164*[Pumping Lift + {2.31*Pumping Pressure}]*ECOST/KWH + [0.003234*Pump Lift]

As shown in equation 9, pumping cost is a function of electricity cost per kwh (ECOST/KWH), pump lift, and pumping pressure. Machinery cost accounts for the maintenance, lube, and repairs of irrigation equipment and is estimated as a function of pump lift (Arabiyat, 1998). Per acre liquid nitrogen cost, the other energy related variable cost, is calculated as acre-inches of applied water multiplied by pounds of liquid nitrogen applied per acre-inch applied water, and this product is then multiplied by the per pound cost of liquid nitrogen.

Non-Hedonic Optimization Framework. The non-hedonic optimization framework is conceptually similar to the hedonic framework with two important exceptions. First, the lint quality equations for micronaire, strength, and staple length (equations 3, 4, 5) are excluded from the constraint set. Thus, in the non-hedonic approach irrigation and fertilizer application rates are allowed to influence lint yield only, and are incorrectly assumed to have no impact on cotton lint quality, and per pound lint price. The second change is directly related to the first, because quality is assumed to be unaffected by input use level, a fixed expected producer price coefficient is substituted for the endogenous price variable in equation 1 (P^H). Because the non-hedonic manager ignores the impact of input use levels on quality, the non-hedonic manager may receive a per unit price less than the expected price. The per pound price the non-hedonic manager actually receives is subsequently calculated by substituting the water and nitrogen application rates that maximize profits in the non-hedonic profit model specification into the hedonic model, and simulating the per pound lint price when these two inputs are used at their non-hedonically determined optimal levels. Thus, it is possible for a non-hedonic producer to achieve a higher per acre yield but receive a lower per pound market price under specific weather patterns and/or input use levels. The average lint price for the 1998 marketing year was used ($0.5807/lb) as producer expected price. The 1998 average marketing year base price was received when all seven lint quality attributes were at their respective base values, where neither a price discount is deducted for below average quality characteristics, nor a price premium paid for above average quality characteristics.

Representative Farm Assumptions. Analytic results are reported for a typical farm on the THP that uses seed variety Paymaster HS 26, the most common seed variety. Thus, the seed variety variable in equations 2, 3, 4, and 5 is fixed in this analysis. The average phosphorous pre-plant application rate of 40 pounds per acre is applied. Irrigation water is applied by a LEPA irrigation system that can apply a maximum of 15 acre-inches of water, per acre, in the growing season. Whole farm cotton budgets for the region were consulted and fixed costs (including all other non-irrigation related variable costs) were estimated to be $381 per acre (USDA 2000). With respect to the electricity related variable cost items, per pound nitrogen cost was set at the average 2001 price of $0.4125 for nitrogen, or $264 per ton of 32% solution, (NASS 20001) and is applied at the recommended rate of 6 pounds per acre inch of applied water (Morrow and Krieg 1990). The baseline electricity rate was set at $.0718/KWH, the average commercial price in 2001 for the THP. Pumping lift and pumping pressure were respectively set at 200 feet and 16.5 PSI, based on information provided by the High Plains Water District (1998).

Weather Scenarios. For purposes of examining the impact climatic conditions have on the relative profitability of hedonic versus non-hedonic management, both management strategies were examined for three weather scenarios. The three scenarios were derived after reviewing 87 years of historic temperature and precipitation data for Lubbock county (National Oceanic and Atmospheric Administration 2001, National Weather Service 2001). The first scenario represents an average weather year. In an average weather year the cotton crop receives 1275 heat units and 9.85 inches of rainfall within the growing season (May-September). The second weather scenario is representative of a cool and wet growing season where the crop receives 1100 heat units and 12.34 inches of rainfall. The third, and final, scenario is for a hot and dry growing season where the crop receives 1400 heat units and only 5.62 inches of rainfall.

Electricity Cost Scenarios. Given the uncertainty surrounding future electric rates in rural areas we present the relative profitability measures of the two alternative management scenarios, for four alternative price scenarios. The alternative electricity price scenarios are: (1) the average rate paid by commercial customers in 2001 ($.0718/kwh), (2) a 10% rate increase, (3) a 30% rate increase, and a 45% rate increase.

RESULTS

This section presents profit comparisons for both hedonic and non-hedonic profit management for the three weather scenarios and four potential electricity cost rates. Across all weather and price scenarios, hedonic management is never less profitable, and is generally more profitable, than non-hedonic management. From a theoretical perspective this is not surprising because, at its most basic level, the hedonic profit maximization approach provides producers with additional management choices, where one management choice remains the non-hedonic management choice. Even though a non-hedonic producer often mistakenly manages for an incorrect expected market price, the per pound price the producer receives at the time of sale is nevertheless a function of the lint=s hedonic quality attributes. Thus, while unlikely, it is possible that both management strategies can generate identical quality characteristics in some situations.

Average Weather Conditions. Under average weather conditions, hedonic profit management generated higher profits than non-hedonic management. Moreover, as electricity price is increased, the value of hedonic management increases relative to non-hedonic management. The hedonic benefit ranges from $5.32 per acre at the baseline electric rate and increases to $8.69 per acre when the baseline electric rate is increased by 45% (Table 1). Despite the fact that hedonic management provides a higher market price than non-hedonic management ($0.56/lb versus $0.55/lb) gross revenue is higher for non-hedonic management due to higher lint yields. Lint yields are higher for non-hedonic management because the non-hedonic manager applies the maximum per acre quantity of water (15 acre-inches/acre), whereas the hedonic manager applies less water (13.09 - 13.60 acre-inches depending on electricity price).

Table 1. Per Acre Revenue and Cost Comparisons of Hedonic Versus Non-Hedonic Cotton Management for a LEPA Irrigated Farm with a 200 Foot Pump: Average Weather Conditions.

	Base Cost	Energy Cost Increase		
Item	($0.0718/kwh)	10%	30%	45%
Profit Hedonic ($/ac)	209.27	205.78	198.85	193.71
Profit Non-Hedonic ($/ac)	203.95	199.74	191.33	185.02
Non-Hedonic Profit Loss ($/ac)	-5.32	-6.04	-7.52	-8.69
Applied Water: Hedonic (ac in/ac)	13.60	13.48	13.26	13.09
Applied Water: Non-Hedonic (ac in /ac)	15.00	15.00	15.00	15.00
Price Hedonic ($/lb)	0.56	0.56	0.56	0.56
Price Non-Hedonic ($/lb)	0.55	0.55	0.55	0.55
Yield Hedonic (lbs/ac)	1,156.55	1,153.93	1,148.81	1,145.07
Yield Non-Hedonic (lbs/ac)	1,183.66	1,183.66	1,183.66	1,183.66
Gross Revenue Hedonic ($/ac)	647.52	647.10	646.19	645.45
Gross Revenue Non-Hedonic ($/ac)	650.48	650.48	650.48	650.48
Hedonic Electricity Related Costs ($/ac)	80.61	83.68	89.70	94.10
Non-Hedonic Elec. Related Costs $/ac)	88.89	93.09	101.50	107.81

Note: In average weather conditions the crop receives 1275 heat units and 9.85 inches of rainfall over the growing season.

Despite the lower gross revenue for hedonic management, anywhere from $2.95 to $5.03 per acre (Table 2) depending upon the cost of electricity, hedonic management is more profitable because irrigated related variable cost is considerably less under hedonic management ($8.27 to $13.71 per acre). The hedonic management cost savings associated with applying less water, in combination with a slightly higher lint price are more than sufficient to offset the slight yield disadvantage of hedonic management.

Table 2. Per Acre Differences in Gross Revenue, Electricity Related Production Costs, and Profit for Non-Hedonic Cotton Production Relative to Hedonic Production for a LEPA Irrigated Farm with a 200 Foot Pump Lift: Average Weather Conditions.

	Base Cost	Energy Cost Increase		
Item	($0.0718/kwh)	10%	30%	45%
Increased Gross Revenue ($/ac)	2.95	3.37	4.29	5.03
Change in Electricity Related Costs ($/ac)				
Increased Energy Cost ($/ac)	3.91	4.68	6.36	7.76
Increased Irrigation Maint. Cost ($/ac)	0.90	0.98	1.13	1.23
Increased Fertilizer Cost ($/ac)	3.46	3.75	4.32	4.72
Total Extra Electricity Related Cost ($/ac)	8.27	9.41	11.81	13.71
Non-Hedonic Profit Reduction ($/ac)	-5.32	-6.04	-7.52	-8.69

Note: In average weather conditions the crop receives 1275 heat units and 9.85 inches of rainfall over the growing season.

Cool and Wet Weather Conditions. The overall empirical results for the cool and wet growing season scenario are generally similar to the average weather scenario except that the magnitude of the economic benefit is considerably larger for hedonic management. The hedonic profit management benefits range from $70.03 to $78.08 per acre (Table 3). As before the non-hedonic manager has higher yields because approximately 5 more inches of water is applied, per acre, than under hedonic management. While the additional water application serves to increase lint yield it does so at the expense of sacrificing lint quality. The per pound market price for lint under hedonic management is $0.58 regardless of electricity cost, but never exceeds $0.51 per pound under non-hedonic management (Table 3).

Table 3. Per Acre Revenue and Cost Comparisons of Hedonic Versus Non-Hedonic Cotton Management for a LEPA Irrigated Farm with a 200 Foot Pump Lift: Below Average Temperature and Above Average Rainfall.

	Base Cost	Energy Cost Increase		
Item	($0.0718/kwh)	10%	30%	45%
Profit Hedonic ($/ac)	242.72	239.83	234.45	229.96
Profit Non-Hedonic ($/ac)	164.63	163.78	161.28	159.93
Non-Hedonic Profit Loss ($/ac)	-78.08	-76.06	-73.17	-70.03
Applied Water: Hedonic (ac in/ac)	9.38	9.32	9.21	9.13
Applied Water: Non-Hedonic (ac in /ac)	14.85	14.68	14.40	14.16
Price Hedonic ($/lb)	0.58	0.58	0.58	0.58
Price Non-Hedonic ($/lb)	0.50	0.50	0.51	0.51
Yield Hedonic (lbs/ac)	1,141.28	1,139.83	1,137.14	1,135.28
Yield Non-Hedonic (lbs/ac)	1,221.40	1,220.34	1,218.36	1,216.54
Gross Revenue Hedonic ($/ac)	656.31	656.09	655.88	655.28
Gross Revenue Non-Hedonic ($/ac)	610.65	613.33	617.84	621.43
Hedonic Electricity Related Costs ($/ac)	55.58	57.83	62.29	65.60
Non-Hedonic Elec. Related Costs ($/ac)	88.01	91.12	97.42	101.79

Note: In the below average temperature and high rainfall weather scenario the crop receives 1100 heat units and 12.34 inches of rainfall over the growing season.

The superior lint quality associated with hedonic management more than offsets the yield reduction and hedonic management generates between $33.84 and $45.66 more revenue per acre than non-hedonic management (Table 4). Due to lower water use, electricity related variable cost is considerably less for the hedonic manager, ranging from $32.43 to $36.19 less per acre. Assuming a 45% increase in electricity cost, electricity expenditure by the hedonic manager is $20.47 less per acre than for the non-hedonic manager (Table 4).

Table 4. Per Acre Differences in Gross Revenue, Electricity Related Production Costs, and Profit for Non-Hedonic Cotton Production Relative to Hedonic Production for a LEPA Irrigated Farm with a 200 Foot Pump Lift: Below Average Temperature and Above Average Rainfall.

	Base Cost	Energy Cost Increase		
Item	($0.0718/kwh)	10%	30%	45%
Reduced Gross Revenue ($/ac)	-45.66	-42.77	-38.05	-33.84
Change in Electricity Related Costs ($/ac)				
Increased Energy Cost ($/ac)	15.34	16.54	18.92	20.47
Increased Irrigation Maint. Cost ($/ac)	3.54	3.47	3.36	3.26
Increased Fertilizer Cost ($/ac)	13.54	13.28	12.85	12.46
Total Extra Electricity Related Costs ($/ac)	32.43	33.29	35.23	36.19
Non-Hedonic Profit Reduction ($/ac)	-78.08	-76.06	-73.17	-70.03

Note: In the below average temperature and high rainfall weather scenario the crop receives 1100 heat units and 12.34 inches of rainfall over the growing season.

Hot and Dry Weather Conditions. The hot and dry weather scenario provides a situation where the hedonic management solution is identical to the non-hedonic solution (Table 5). Per acre profit is identical because the hot weather in combination with low rainfall necessitates that both managers maximize their use of applied water (both apply the maximum of 15 acre-inches per acre). Even though both managers apply the maximum quantity of available water, yields are as much 20% lower then they were in the prior two weather scenarios. This suggests that the additional revenue generated by increasing lint yields at low per acre production levels, is more profitable than managing for quality when yields are low due to water supply scarcity.

Table 5. Per Acre Revenue and Cost Comparisons of Hedonic Versus Non-Hedonic Cotton Management for a LEPA Irrigated Farm with a 200 Foot Pump Lift: Above Average Temperature and Below Average Rainfall.

	Base Cost	Energy Cost Increase		
Item	($0.0718/kwh)	10%	30%	45%
Profit Hedonic ($/ac)	133.86	129.65	121.24	114.93
Profit Non-Hedonic ($/ac)	133.86	129.65	121.24	114.93
Non-Hedonic Profit Loss ($/ac)		0.00	0.00	0.00
Applied Water: Hedonic (ac in/ac)	15.00	15.00	15.00	15.00
Applied Water: Non-Hedonic (ac in /ac)	15.00	15.00	15.00	15.00
Price Hedonic ($/lb)	0.59	0.59	0.59	0.59
Price Non-Hedonic ($/lb)	0.59	0.59	0.59	0.59
Yield Hedonic (lbs/ac)	979.43	979.43	979.43	979.43
Yield Non-Hedonic (lbs/ac)	979.43	979.43	979.43	979.43
Gross Revenue Hedonic ($/ac)	580.39	580.39	580.39	580.39
Gross Revenue Non-Hedonic ($/ac)	580.39	580.39	580.39	580.39
Hedonic Electricity Related Costs ($/ac)	88.89	93.09	101.50	107.81
Non-Hedonic Elec. Related Costs ($/ac)	88.89	93.09	101.50	107.81

Note: In the above average temperature and low rainfall weather scenario the crop receives 1400 heat units and 5.62 inches of rainfall over the growing season.

SUMMARY AND CONCLUSIONS

The optimization results revealed significant differences between hedonic and non-hedonic profitability. Not surprisingly, as economic theory would suggest, hedonic management is more profitable than non-hedonic profit maximization given the modeling assumptions. However, the magnitude of increased profitability value for hedonic management in a cool wet year was surprising, hedonic management generated $78.08 more profit per acre than non-hedonic management. Per acre energy related variable cost is also considerably less under hedonic management, and the per acre cost saving increases as electricity price increases. Moreover, assuming a 45% increase in the price of electricity and average weather conditions, energy related variable cost is $13.71 less per acre than under non-hedonic management and 56.6% of the cost savings is attributable to decreased electricity expenditures. In addition to the reported cost savings, the use of irrigation water is generally less under hedonic management, and is as much as 36.8% less under the cool and wet weather scenario (Table 3). Clearly input management decisions can have a profound influence on per acre profit, lint yield, lint quality, lint price, and production cost.

While these empirical results are consistent with the hedonic valuation literature, the magnitude of the reported differences between hedonic versus non-hedonic profit maximization are conditioned on the experimental data used to quantify the lint yield and lint quality response to applied water and nitrogen, and the 1998 DPES equation. The production response models were estimated by Britt *et al.* (2002), using three years of experimental data collected under intensive management practices in one Texas county. The reported results for lint yield and quality characteristics, and overall profitability, will likely vary with the various soil types and management practices of the Texas High Plains. However, from a theoretical perspective, hedonic profit maximization will always generate a per acre profit level greater than or equal to non-hedonic profit maximization for any given set of management practices. Finally, the empirical results were derived under the assumption that the producer had perfect knowledge of growing season rainfall and accumulated heat units. This assumption is heroic given current weather forecasting capabilities. But with the continuing advances in precision agriculture technology, the need for perfect weather forecasts will be greatly diminished, because precision agricultural techniques allow management to continuously adjust input use levels to compensate for changing weather conditions and facilitate hedonic profit maximization. Clearly additional economic research is needed to determine the on-farm plausibility of managing for hedonic characteristics. However, the economic incentive is there, and the agricultural payoff could be enormous.

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