Citrus fruits - Cost of production

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PROFIT VOLATILITY AND WATER-ENERGY DEMAND ELASTICITIES IN CITRUS PRODUCTION

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ABSTRACT

The demand for energy and irrigation water by the Florida citrus industry is shown to be relatively inelastic for energy price increases upward to 300 percent. As expected, product price increases have a more dramatic effect on profit than do energy price increases. A small product price increase can easily offset a much larger increase in energy prices.

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Agricultural producers in the United States have experienced dramatic increases in the cost of all forms of energy. Further increases will certainly occur (Landsberg). To remain competitive producers will have to adjust to these higher energy costs.

Agricultural producers in Florida may be especially affected. Due to the low soil fertility, the low water holding capability of soils, and the tropical environment, the state of Florida is a large user of fertilizer, energy for irrigation pumps, and pesticides. All of these are at least partially derived from fossil fuels. Approximately 35 percent (as measured in BTU's) of the total energy used in crop production in Florida was used for irrigation, fertilization, or pesticides (USDA). Citrus growers may be particularly influenced. There are approximately 850,000 acres of citrus in Florida of which approximately 530,000 are under some type of irrigation (Stanley, et al.). Citrus accounts for 31 percent of all irrigated acreage in the state. About 41 percent of all freshwater withdrawn is used for irrigation (USGS).

Florida is not alone in facing the problem of increased energy costs affecting irrigation operations. Many areas of the country have used supplemental irrigation, of course, to increase crop yield and increase profits. In a study of the Texas High Plains, Young and Coomer projected that under a constant output price, net farm income for the study area would decrease from $277 million in 1976 to $164 million in the year 2025 if natural gas prices were to steadily increase from $2.45 per MCF (thousand cubic feet) to $9.65 per MCF. Under this same set of conditions irrigation of the major crops in the area would terminate by 1995.

Lacewell et al. estimated that increasing natural gas prices could reduce the value of the groundwater in the Texas High Plains by 50 percent. The same study predicted the average life expectancy of a farm in the Trans Pecos region of Texas to be approximately 5 years assuming energy prices rise faster than crop prices.

Output price was shown to have a dramatic effect in a study by Lacewell and Condra. They allowed output price to vary and examined the effect on demand for various energy related inputs. At low output prices the quantity of diesel demanded dropped when the price rose above $0.56 a gallon. When output prices were average or high, diesel was still in high demand at $1.35 a gallon. Under high output prices, maximum irrigation continues to occur at a diesel price of $5.00 a gallon. They concluded that the greatest impact of rising diesel prices would be on the net income of farmers. Also, output prices have a much greater effect on net income than do input prices.

Mapp and Eidman in a study of northwestern Oklahoma examined the impact of rising natural gas prices on the water use by supplemental irrigation. They devised three water resource situations: poor, moderate and good. These are based primarily on saturated thickness of the underlying water and the depth to the water table. The findings were that the amount of irrigated acres on a representative farm was highly dependent on the water situation when constant natural gas prices were assumed. For example, when high crop prices were assumed only about 120 acres were irrigated 45 years in the future under a poor water situation whereas under a good water situation over 400 acres were irrigated. The effect on net revenue was not as great, however. Under constant natural gas prices, 40 years in the future the net returns for the representative farm under poor, moderate and good water situations was $71,000, $85,000 and $90,000 respectively.

Problem Setting and Approach

While the citrus producers in Florida are adjusting to higher energy costs they are also facing an uncertain future with regard to water. The Florida Water Resources Act of 1972 created water management districts with broad statutory powers. The policy sets forth that "...the waters of the state are among it's basic resources. Such waters have not heretofore been conserved or fully controlled so as to realize their full beneficial use." (Carriker and Lynne). Permits are now required to withdraw water and the applicant must establish that the proposed use of water is for a reasonable-beneficial use.

This puts the citrus producer who irrigates in a precarious situation. On one hand, he wishes to use less energy since the price is increasing but on the other hand some energy saving irrigation systems may use more water. Also, some water saving systems use more energy. The producer may also face an increased demand for his product which may cause him to increase his output via irrigation due to a higher market price of his product.

Water, energy and labor may substitute for each other over a narrow range so the producer must examine the relative costs in determining a least cost irrigation system. At this time Florida does not charge for withdrawing water, however, those costs associated with a particular irrigation system may be assumed to be the water costs since water in nature must be transformed into a useable form (irrigation water) to be of any value to the producer.

The overall purpose of this paper is to provide further empirical evidence of relative affects on profits from product price versus fuel price changes. Also, further insight is provided on the elasticity of demand for water and energy, for changes in fuel prices.

Model and Data

The primary objective of this (currently in progress) study is to determine the optimal allocation of energy, water, labor, and land resources with respect to irrigation under various input/output price scenarios. The industry is assumed to be the aggregate of many small producers partitioned into homogeneous groups, and is assumed to desire maximum profits.

A linear programming model is used, where the matrix is partitioned into water demand and water supply sections. Citrus production (water demand) activities in the model were developed from published budgets with the energy components partitioned out (Muraro). Irrigation water supply activities have water, energy and labor partitioned out (Harrison). The production functions for the citrus types are represented by three levels of irrigation, as well as dryland production. Seven types of irrigation systems are included--traveling gun, portable gun, permanent overhead, drip, low volume spray, portable pipe and seepage. Energy sources available are diesel, electricity and LP-gas. Two soil types and four production regions are represented. These activities as well as the buy, sell and transfer activities give rise to a 200 x 700 matrix.

To restrict the model to the present situation and establish a base run, survey data is used to estimate the number of acres now under irrigation by system type and energy source (Stanley et al.). Input and output prices can then be varied to see the affect on input demand and output, from this base run.

Model Results

Diesel, LP-gas and electricity for irrigation as well as diesel and gasoline partitioned out of the dryland budgets were parametrically allowed to increase in increments of 50 percent of their present cost. Output price was held constant at $0.62 per pound solid. The effect of these price increases is presented in Tables 1 and 2. Output price was then changed to $0.72 per pound solid and the same increases in energy costs were made. These results are presented in Tables 3 and 4.

The overall results obtained were generally consistent with those of Lacewell and Condra. At a low product price, $0.62 per pound, demand for energy for irrigation begins to decline as energy prices increase (Tables 1 and 2). However, the quantity of water used stays relatively constant, dropping only about 16 percent (from 6.3 to 5.3 million acre inches, Table 1) for an energy price increase of 300 percent, suggesting a relatively inelastic demand curve for water. With respect to fuel energy demand, the demand is perfectly inelastic for price increases through 100 percent for all fuel types for all purposes (Table 1) and through a 150 percent increase for irrigation only (Table 2). In fact, the demand for electricity (used only for irrigation) stays virtually constant through a price increase of 300 percent. When product prices are higher, at $0.72 per pound, the demand for energy is essentially perfectly inelastic (Tables 3 and 4) except for a slight decline in diesel fuel use at the 300 percent level (Table 4). But even for diesel, the price must approach $4.00 per gallon before any effect will be noticed. This finding is in contrast to substantial impacts above $0.56 per gallon for

Table 1.--Effect of rising energy costs on net revenue, water used, energy used and total yield of round oranges for the processed market under constant output price of $0.62 a pound, Florida, 1979-80.

Energy prices	Industry profit	Water used	Total yield	Diesel used	LP gas used	Electricity used	Gasoline used
	Dollars	Acre-inches	lbs. solids	Gallons	Gallons	Kw.H.	Gallons
Present	173,572,385	6,325,197	1,186,264,838	29,953,447	1,111,419	52,909,478	8,386,881
50% Increase	150,554,328	6,325,197	1,186,264,838	29,953,447	1,111,419	52,909,478	8,386,881
100% Increase	127,602,386	6,325,197	1,181,807,395	29,836,836	1,111,419	52,909,478	8,336,150
150% Increase	104,748,794	6,194,855	1,178,184,530	29,254,256	1,111,419	52,655,040	8,336,150
200% Increase	82,695,122	6,012,092	1,109,779,784	26,945,389	1,066,339	52,469,240	7,674,556
300% Increase	49,251,599	5,313,824	686,803,871	15,936,921	854,851	51,233,481	4,108,329

Table 2.--Effects of rising energy costs on level of irrigation and energy used for irrigation in the production of round oranges for the processed market under a constant output price of $0.62 a pound, Florida, 1979-80.

Energy prices	Total production	Dryland production	Medium irrigation	High irrigation	Diesel for irrigation	Electricity for irrigation	LP gas for irrigation
	Acres	Acres	Acres	Acres	Gallons	Kw.H.	Gallons
Present	675,774	300,618	0	375,156	11,118,846	52,909,478	1,111,419
50 % increase	675,774	300,618	0	375,156	11,118,846	52,909,478	1,111,419
100% increase	672,252	297,096	0	375,156	11,118,846	52,909,478	1,111,419
150% increase	672,252	297,096	24,002	351,154	10,536,266	52,655,040	1,111,419
200% increase	626,307	262,595	22,128	341,584	9,748,145	52,469,240	1,066,339
300% increase	340,779	0	79,458	261,321	6,756,957	51,233,481	854,851

Table 3.--Effect of rising energy costs on net revenue, water used, energy used and total yield of round oranges for the processed market under constant output price of $0.72 a pound, Florida, 1979-80.

Energy prices	Industry profit	Water used	Total yield	Diesel used	LP gas used	Electricity used	Gasoline used
	Dollars	Acre-inches	lbs. solids	Gallons	Gallons	Kw.H.	Gallons
Present	292,198,869	6,325,197	1,186,264,838	29,953,447	1,111,419	52,909,478	8,386,881
50% increase	269,180,812	6,325,197	1,186,264,838	29,953,447	1,111,419	52,909,478	8,386,881
100% increase	246,162,756	6,325,197	1,186,264,838	29,953,447	1,111,419	52,909,478	8,386,881
150% increase	223,144,699	6,325,197	1,186,264,838	29,953,447	1,111,419	52,909,478	8,386,881
200% increase	200,170,594	6,246,037	1,184,121,817	29,599,630	1,111,419	52,848,616	8,386,881
300% increase	154,805,774	6,138,214	1,181,108,618	29,117,706	1,111,419	52,655,040	8,386,881

Table 4.--Effects of rising energy costs on level of irrigation and energy used for irrigation in the production of round oranges for the processed market under a constant output price of $0.72 a pound, Florida, 1979-80.

Energy prices	Total production	Dryland production	Medium irrigation	High irrigation	Diesel for irrigation	Electricity for irrigation	LP gas for irrigation
	Acres	Acres	Acres	Acres	Gallons	Kw.H.	Gallons
Present	675,774	300,618	0	375,156	11,118,846	52,909,478	1,111,419
50% increase	675,774	300,618	0	375,156	11,118,846	52,909,478	1,111,419
100% increase	675,774	300,618	0	375,156	11,118,846	52,909,478	1,111,419
150% increase	675,774	300,618	0	375,156	11,118,846	52,909,478	1,111,419
200% increase	675,774	300,618	14,577	360,578	10,765,029	52,848,616	1,111,419
300% increase	675,774	300,618	34,433	340,723	10,283,105	52,655,040	1,111,419

the Lacewell and Condra study in Texas. Of course, that study was on more extensive field crops as opposed to the relatively intensive citrus, orchard crop reported herein.

Interestingly, dryland production of citrus terminates before irrigated citrus (Table 2) in contrast to the findings of Young and Coomer for crops on the Texas High Plains. There were relative shifts toward lower levels of irrigation, however, as energy prices increased (Tables 2 and 4), which would be expected.

Table 5 presents elasticities for increasing energy price and increasing product price. The "profit elasticity" for product price, increases as energy prices increase. For example, at present energy costs a 1 percent increase in the product price results in a 4.27 percent increase in industry profits but when energy prices are 200 percent higher a 1 percent increase in product price results in a 13.27 percent increase in industry profits. This again suggests that product prices will have a much greater effect on industry profit than energy prices.

The profit elasticities associated with a change in fuel costs are shown to be constant at -0.26 and -0.16 for product prices of $0.62 and $0.72, respectively. This simply provides quantitative expression of the intuitively obvious fact that profits are reduced less, percentage wise, when product prices are higher.

A surprising result was the relative magnitudes of the elasticities, especially at high energy prices. The fuel price "profit elasticity" stays constant at -0.16 to -0.26, but the product price profit elasticity is over 13, suggesting much larger percentage changes in profits can be expected as fuel prices increase through time. This suggests farmers will be affected even more by volatile product price conditions as energy pri-

Table 5.--Profit elasticities for energy price increases and product price increases for round oranges for the processed market, Florida 1979-80.

Percent	Profit elasticity for energy price increases given product price of $0.62	$0.72	Profit elasticity for product price increases from $0.62 to $0.72
Present			4.27
50	-0.26	-0.16	4.92
100	-0.26	-0.16	5.81
150	-0.26	-0.16	7.07
200	-0.26	-0.16	8.88
300	-0.24	-0.16	13.37

ces increase. Of course, this is simply supporting the intuitively acceptable idea that farmers will be affected more by product price changes when profit margins narrow. This also suggests a relatively small product price increase could offset a large energy price change, especially for higher energy prices.

Implications

The findings of this study were that irrigation of citrus in Florida is profitable and will remain profitable in the face of rising energy prices. Dryland production of citrus was found to not be profitable as energy prices increased.

Output price, as expected, has even a greater effect on industry net returns. A price rise of $0.10 a pound (from $0.62 to $0.72) will more than offset a 200 percent increase in energy costs. Because of this the industry will most likely use water and energy at current rates despite large increases. Since irrigation is so attractive to citrus producers the State Water Districts cannot rely on energy price hikes to help solve the problem of increased demand for water in Florida. Or, viewed alternatively, it appears the citrus industry could effectively compete for water with substantial increases in its costs.

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