A REGIONAL ANALYSIS OF VEGETABLE PRODUCTION WITH CHANGING DEMAND FOR ROW CROPS USING QUADRATIC PROGRAMMING

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Abstract

The purpose of the study was to ascertain the competitive and complementary potential of fresh vegetable production relative to traditional row crop production using a regional partial equilibrium model. It seems clear from the analysis that vegetable crops are not destined in the near future to replace row crops in terms of land utilization. Nevertheless, vegetable crops appear to compete with and complement row crops well as evidenced by substantial increases in production as market share was assumed to increase. However, fresh vegetables cannot be considered as residual enterprises to which producers move when the demand for row crops declines. Even with a simulated 20 percent decrease in the demand for row crops, the acreage of fresh vegetables did not increase.

Key words: market share, alternative crops, welfare analysis, southeast.

The cyclical nature of economic conditions in the U.S. is quite apparent in the agricultural sector both nationally and regionally. After the golden era of the 1970s for U.S. agriculture, economic conditions began to deteriorate rapidly in many agricultural areas of the U.S. The southeastern U.S. shared in this decline, especially in regions where large acreages of row crops traditionally have been produced.

In the tri-state area of North Carolina, South Carolina, and Georgia, the aggregate nominal value of farmland and buildings fell almost 17 percent from 1981 to 1985, and from 1981 to 1984 the aggregate nominal value of farm mortgage loans rose more than 21 percent (U.S. Department of Agriculture (f)). From 1981 to 1986 nominal prices for major row crops such as corn, soybeans, wheat, and cotton were generally down—corn 32 percent, soybeans 21 percent, wheat 25 percent, and cotton 7 percent. Since 1986, however, prices have begun to improve except in the case of cotton (U.S. Department of Agriculture (f) and recent price quotes from the North Carolina, South Carolina, and Georgia Agricultural Statistics Services, U.S. Department of Agriculture).

Because of dramatic shifts in the profitability of traditional row crops, an interdisciplinary research team was formed comprised of researchers from North Carolina, South Carolina, and Georgia to ascertain the potential for producing vegetables as competing or complementary enterprises in the tri-state area. The project was deemed plausible because of an abundance of natural resources, human capital stock, and an array of climates in the area. Underground water, irrigation systems in place, and vast areas of quality land without the threat of urban encroachment are available in the tri-state area (Davis and Meyer; Geraghty et al.; Kiker and Lynne; Kundell; La Moreaux; Meister et al.; Todd; Babb et al.).

Because the fresh vegetable industry has been growing slowly, though steadily, in the area since the early 1970s, numerous packing operations, which deal through major brokerage firms or direct with major food chains, are already in place. Moreover, tobacco production, which requires the same intensive management as commercial vegetable production, is common in the tri-state region. Fur-

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ther, the growing season in the tri-state area is as long as 290 days on the coast and as few as 200 days in the mountainous region. It is possible that three or four plantings of some vegetable crops could be produced in certain regions of the tri-state area with cool season crops being grown in the summer in the mountains (Decoteau et al.). There is also the potential of multiple cropping systems composed of horticultural and row crops (Tew et al.).

This study focuses on the potential for producing fresh vegetables for the national market throughout the year to the extent possible in the study area which corresponds largely to the tri-state area of Georgia, South Carolina, and North Carolina. The study area was defined by biological scientists on the tri-state research team with the goal of providing the greatest physical possibility of being able to supply vegetables over as much of the year as possible from somewhere in the study area. The biological scientists further divided the study area into four climate zones or regions. Region 1 encompasses the lower coastal plain of southwestern Georgia, northwestern Florida, and southeastern Alabama. Region 2 includes the lower coastal plain of South Carolina. Region 3 consists of the upper coastal plain of Georgia, South Carolina, and North Carolina. Region 4 is composed of the mountainous region encompassing parts of northern Georgia, northwestern South Carolina, western North Carolina, and eastern Tennessee.

In order to ascertain the competitive and complementary potential of fresh vegetable production relative to traditional row crop production in the tri-state area, a regional partial equilibrium model similar to that of Adams et al. and Mathia and Brooker is employed which is couched in a quadratic programming framework.[1] The model, which encompasses multiple production activities for 11 selected fresh vegetables and five row crops, 12 monthly time periods, and four regions, has three major components: demand, production cost including risk, and a constraint set. The analysis employs a comparative static procedure such that model solutions involving an array of possible fresh vegetable market shares and different simulated demands for row crops are compared to a base solution. The base solution tracks average production of row crops in the tri-state area based on the 1980–1984 period.

THE PROGRAMMING MODEL

The basic quadratic programming model used in this study is the interregional activity formulation of Takayama and Judge. The study model differs from the formulation of Takayama and Judge in that it does not contain a transportation component. The focus of this study is to determine the relative competitiveness of alternative cropping activities in specified regions as opposed to spatial allocation of commodities among regions of demand. The model, which maximizes net social payoff (NSP),[2] in matrix-vector notation is as follows:

(1) Max NSP (Y X)

$$= [A \; -C][Y \; X]' - (1/2)[Y \; X]\begin{bmatrix} D & O \\ O & O \end{bmatrix}[Y \; X]'$$

$$\text{s.t.} \begin{bmatrix} I & -E \\ O & G \end{bmatrix}[Y \; X]' \leq [O \; L]',$$

and

$$[Y \; X]' \geq [0]',$$

where Y = a row vector of monthly aggregate demand of each commodity in 100 cwt; X = a row vector of regional activity levels in 100 cwt; A = a row vector of intercepts (dollars per 100 cwt) of price dependent demand equations; C = a row vector of costs per 100 cwt, including variable and risk costs of production; and D = a nonnegative diagonal submatrix of demand coefficients without cross-price flexibilities. The quadratic form should be positive semidefinite to ensure that the algorithm reaches a global maximum (Takayama and Judge). This condition is satisfied in that the diagonal elements of D are positive and the off-diagonal elements are zero. In the constraint set, I = an identity submatrix; E = a submatrix including elements of 1 and 0 so as to facilitate the subtraction as depicted in equation (2); G = a submatrix of land constraint coefficients in acres per 100

[1]This study does not address the ability of the Southeast to compete in U.S. vegetable markets. Rather, an array of market shares is assumed. Actual market shares are used for those vegetables that are commercially produced in the study area except in cases where the assumed market share is greater than the actual market share.

[2]Net social payoff, the net of consumer and producer surplus, has been used often to formulate the objective function in regional competition models (Takayama and Judge). The optimizing framework used is designed for a competitive market structure which is largely characteristic for fresh produce and field crops. Net Social Payoff has been used frequently as a measure of welfare in order to differentiate among alternative scenarios (Adams et al.; Dahlgran; Hammig et al.). Net Social Payoff is used in a similar manner in this study.

cwt; and L = a row vector of the availability of cropland by region and growing season in acres.

The model places constraints on the quantity demanded, the available cropland, and the nonnegativity of demand and supply. The aggregate monthly quantity demanded, y, is constrained to be less than or equal to the monthly quantity harvested from all producing regions. Thus,

(2) $IY - EX \leq 0.$

Cropland is constrained by the availability of cropland in each region and growing period. Thus,

(3) $G X' \leq L'.$

Finally, demand and supply quantities are constrained to be nonnegative such that

(4) $[Y\ X]' \geq [0]'.$[3]

MODEL COMPONENTS

Demand Component

Price-quantity demand functions for the fresh vegetable and row crops were computed from price elasticity estimates from previous studies, except in the case of "additional" peanuts for which a price elasticity estimate was not found. Seasonal data from the U.S. Department of Agriculture (f) and unpublished price data from the Commodity Analysis Division, ASCS, U.S. Department of Agriculture were used to estimate a price-quantity demand function for "additional" peanuts (i.e., peanuts produced for the export market). Since the government program was not changed until 1977 (Carley and Fletcher; Stucker and Collins), eliminating restrictions on the production of peanuts for the export market, and because of the extreme drought of 1980, only six observations for "additional" peanuts were available for the period 1978–1984.

Price flexibilities used to compute slope coefficients for the U.S. demand functions for selected fresh vegetable and row crops are

TABLE 1. U.S. PRICE ELASTICITY ESTIMATES AND SOURCES BY FRESH VEGETABLE AND ROW CROP

Commodity	Price Elasticity	Source
Vegetable crops		
Snap beans	−0.5000	Mathia and Brooker
Cucumber	−0.1980	Mittelhammer
Broccoli[a]	−0.1980	
Cauliflower[a]	−0.1980	
Bell pepper	−0.1110	Mittelhammer
Cantaloupe	−1.4370	Price and Mittelhammer
Carrots	−0.0388	Huang
Greens[b]	−0.0385	
Leaf lettuce[c]	−0.1371	
Potatoes	−0.3688	Huang
Tomatoes	−0.5584	Huang
Row crops		
Corn	−0.4202	Ray and Richardson
Soybeans	−0.5000	Ray and Richardson
Wheat	−0.3000	Ray and Richardson
Cotton	−0.5714	Ray and Richardson

[a]Price elasticity estimates for broccoli and cauliflower were not found. However, since broccoli and cauliflower may be considered salad vegetables similar to cucumber, price elasticity estimates for broccoli and cauliflower were assumed to be the same as that for cucumber.

[b]Price elasticity estimates for greens such as collard greens, turnip greens, or mustard greens were not found. However, since greens are staples for those who consume them, much like cabbage, the price elasticity for greens was assumed to be the same as that for cabbage as estimated by Huang.

[c]A price elasticity estimate for leaf lettuce was not found; thus, the estimate for iceberg or head lettuce as estimated by Huang was assumed for leaf lettuce.

[3]There are several factors that may constrain producers from switching enterprises in the short run which are not addressed in this study, such as the availability of skilled and unskilled labor, flexibility of the machinery complement, and limitations in management capability. The impact of such constraints would likely be more accurately quantified with a firm-level analysis.

assumed to be the reciprocals of the price elasticity estimates shown in Table 1.[4] Computation of U.S. demand functions for the vegetables was based on average monthly price and quantity for each commodity for 1980–1984 (U.S. Department of Agriculture (a-f)). Computation of U.S. demand functions for the row crops was based on season average price and quantity for each crop for 1980–1984 (U.S. Department of Agriculture (f)). Monthly quantities (shipments) for each vegetable commodity were obtained from U.S. Department of Agriculture (d). However, since monthly shipments do not account for total production, the monthly shipment data were adjusted by annual shipment-production ratios (U.S. Department of Agriculture (d,f)).

In order to obtain monthly demand functions with respect to the study area for the 11 vegetable crops, U.S. monthly demand functions were adjusted in a manner similar to that of Mathia and Brooker. In the analysis to follow, an array of possible or assumed market shares, 1 percent, 5 percent, 10 percent, and 20 percent, for the 11 vegetable commodities is considered for the study area. Thus, the slopes of the demand functions are adjusted to reflect assumed market shares; that is, the slopes of the U.S. demand functions for the vegetable commodities are divided by the array of market share ratios to obtain demand functions with respect to the study area that reflect the assumed market shares. Seven of the 11 fresh vegetables considered in this study have historically been produced in the study area. These include snap beans, cucumber, bell pepper, cantaloupe, greens, potatoes, and tomatoes. Since actual market shares exist for these vegetables, actual market shares were used for these vegetables to obtain demand functions for the study area if the actual market share exceeded the assumed market share.[5]

The analysis of vegetable production for the tri-state region assuming different market shares was carried out with varying simulated demands for row crops. Simulated decreases in row crop demand varied from 10 percent to 20 percent, while simulated increases varied from 10 percent to 30 percent. The impacts on vegetable crop production are depicted for the actual or base level demands for row crops, a 20 percent decrease, and a 30 percent increase in demands for row crops. Row crop demands were varied by adjusting the intercepts of the demand functions.

Production Cost Component

Production costs used in this study include variable costs, reflecting the short-run nature of the analysis, and risk costs. Sources of variable cost estimates were selected by agricultural economists and biological scientists from the tri-state area on the basis of relevance to a particular region in the study area. Variable cost and yield estimates were obtained from extension budgets from North Carolina, South Carolina, Georgia, Florida, and Texas. A procedure similar to that of Adams et al. was used to compute risk cost. Risk cost is the product of variable cost and the coefficient of variation (risk coefficient).[6]

Price variability was used to estimate risk coefficients for the fresh vegetable crops, while yield variability was used for the row crops. Price variability by month for the vegetable crops was estimated using monthly F.O.B. prices for the period 1975–1984 (U.S. Department of Agriculture (b,c)). Yield variability by region of the study area for the row crops was estimated from yield data for the period 1975–1984 (Crop Reporting Services for Alabama, Florida, Georgia, North Carolina, South Carolina, and Tennessee).

Other forms of variation have been used to capture risk in programming models. For example, Adams et al. used only yield variability for both vegetable and row crops, while Hazell and Scandizzo and Simmons and Pomarada employed gross returns. In this study, price data were used in estimating risk coefficients for fresh vegetables in the study area because yield data are not generally available, while yield data were used for row crops since yield data possess relatively more variability than price data for row crops.[7]

Land Constraint Component

Land constraints by region of the study area were set at total average acres of land in use

[4]Strictly stated, the reciprocal of price elasticity is the lower absolute limit of the price flexibility (Houck).

[5]Monthly price-quantity relationships for selected fresh vegetables for the United States and the study area and price-quantity relationships for selected row crops for the United States and the study area are available upon request from the authors.

[6]The risk coefficients used in Adams et al. and Johnston are from Carter and Dean. Carter and Dean used the variate difference method to compute variability coefficients.

[7]Production costs for selected fresh vegetable crops by region of the study area and month of harvest and production costs for row crops by region of the study area are available upon request from the authors.

in the peak season for row crops in 1983–1984, excluding crops regulated by the government such as tobacco and quota peanuts: 1,910,630 acres in region 1; 215,670 acres in region 2; 5,332,502 acres in region 3; and 474,490 acres in region 4 (Crop Reporting Services for Alabama, Florida, Georgia, North Carolina, South Carolina, and Tennessee). The land constraint coefficients are the reciprocals of yields in 100 cwt. per acre. Yields were obtained from Extension budgets for North Carolina, South Carolina, Georgia, Florida, and Texas.

For many crops in a given region, the growing seasons do not overlap, thus there is no competition for land in such instances. However, there are many cases where growing seasons for vegetables and row crops overlap in a given region causing competition for land. For this reason, biological constraints were employed in the quadratic programming model to ensure that crops with overlapping growing seasons in a given region could not occupy the same area of land. The biological constraints allow planting of a particular crop in the month that harvesting is complete for some other crop in a given region.

TABLE 2. EFFECTS OF ALTERNATIVE MARKET SHARES FOR FRESH VEGETABLES AND CHANGING DEMAND FOR ROW CROPS ON ACREAGE IN THE STUDY AREA FOR A GIVEN YEAR

				Market Share							
		Base		1%		5%		10%		20%	
Commodity	Actual Acreage	Model Acreage	Diff. (%)[a]	Acreage	Diff. (%)[b]	Acreage	Diff. (%)[b]	Acreage	Diff. (%)[b]	Acreage	Diff. (%)[b]
Vegetable crops											
Snap beans	12,460	15,257	22.45	15,381	0.81	15,882	4.10	16,506	8.19	18,537	21.50
Cucumber	12,447	12,948	4.02	13,041	0.72	13,577	4.86	15,276	17.98	19,020	46.90
Broccoli	NA	NA	NA	378	NA	1,896	NA	3,788	NA	7,580	NA
Cauliflower	NA	NA	NA	347	NA	1,732	NA	3,467	NA	6,933	NA
Bell pepper	2,637	2,781	5.46	3,125	12.37	4,697	68.90	6,747	142.61	11,771	323.26
Cantaloupe	2,051	3,040	48.22	3,840	26.32	11,135	266.28	22,270	632.57	44,543	1,365.23
Carrots	NA	NA	NA	868	NA	4,347	NA	8,687	NA	17,374	NA
Greens	1,393	1,417	1.72	1,417	0	1,417	0	1,417	0	1,417	0
Leaf lettuce	NA	NA	NA	30	NA	149	NA	297	NA	593	NA
Potatoes	1,581	1,808	14.36	4,830	167.15	19,873	999.17	39,745	2,098.29	79,486	4,296.35
Tomatoes	5,504	6,407	16.41	6,577	2.65	7,997	24.82	10,022	56.42	14,582	127.59
Subtotals by row crop demand											
Base	38,073	43,658	14.67	49,834	14.15	82,702	89.43	128,222	193.70	221,836	408.12
20% decrease				49,834	14.15	82,702	89.43	128,222	193.70	221,836	408.12
30% increase				49,311	12.95	81,856	87.49	127,213	191.39	219,374	402.48
Row crops											
Corn	3,399,553	3,325,147	−2.19	3,325,207	0	3,325,156	0	3,325,151	0	3,295,145	−0.90
Soybeans	4,059,760	4,006,813	−1.30	4,006,790	0	4,006,687	0	4,006,561	0	3,998,394	−0.21
Wheat	1,925,527	1,925,492	0	1,925,492	0	1,925,492	0	1,925,492	0	1,925,492	0
Cotton	253,887	253,898	0	253,898	0	253,898	0	253,898	0	253,217	−0.27
"Additional" peanuts	219,676	227,603	3.61	227,603	0	227,603	0	227,603	0	227,327	−0.12
Subtotals by row crop demand											
Base	9,858,403	9,738,953	−1.21	9,738,990	0	9,738,835	0	9,738,702	0	9,700,684	−0.39
20% decrease			−1.21	4,386,161	−54.96	4,386,160	−54.96	4,386,160	−54.96	4,368,420	−55.14
30% increase			−1.21	10,918,383	12.11	10,905,614	11.98	10,886,637	11.78	10,847,262	11.38
Totals by row crop demand											
Base	9,896,476	9,782,611	−1.15	9,788,824	0.06	9,821,537	0.40	9,866,924	0.86	9,922,520	1.43
20% decrease			−1.15	4,435,995	−54.65	4,468,862	−54.32	4,514,382	−53.85	4,590,256	−53.08
30% increase			−1.15	10,967,694	12.11	10,987,470	12.32	11,013,850	12.59	11,066,636	13.12

Note: Actual market shares for snap beans, cucumber, greens, and tomatoes exceed certain market share categories depicted in this table in certain months.

[a]Difference = (Base Acreage − Actual Acreage)/Actual Acreage.

[b]Difference = (Adjusted Acreage − Base Acreage)/Base Acreage.

Table 3. Monthly Production of Selected Fresh Vegetable Crops Assuming a Ten Percent Market Share for the Study Area

Commodity	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	Harvest Period											
	100 cwt											
Base/20% decrease in row crop demand[a]												
Snap beans	NA	NA	NA	654	970	2,738	1,125	575	561	1,314	705	NA
Cucumber	NA	NA	NA	1,301	1,631	8,970	4,747	784	693	2,591	1,324	NA
Broccoli	NA	NA	NA	459	463	392	342	325	377	403	444	536
Cauliflower	416	295	NA	290	322	286	254	236	289	417	373	379
Bell pepper	NA	NA	NA	833	949	1,546	479	473	633	658	794	NA
Cantaloupe	NA	NA	NA	1,833	3,825	6,705	6,716	4,430	2,497	1,406	426	NA
Carrots	2,651	1,385	1,709	1,634	1,538	1,415	1,039	861	975	1,063	1,138	1,297
Greens	644	676	943	852	700	222	226	202	290	326	332	747
Leaf lettuce	NA	NA	93	67	52	26	33	34	30	27	68	164
Potatoes	NA	NA	NA	15,623	16,400	9,851	8,528	9,419	9,433	10,236	NA	NA
Tomatoes	NA	NA	NA	NA	4,634	12,750	6,086	2,197	2,564	3,241	3,087	NA
30% increase in row crop demand												
Snap beans	NA	NA	NA	654	970	2,674	1,100	557	561	1,314	705	NA
Cucumber	NA	NA	NA	1,301	1,631	8,897	4,697	784	693	2,591	1,324	NA
Broccoli	NA	NA	NA	459	463	392	338	322	373	403	444	536
Cauliflower	416	295	NA	290	322	284	252	234	287	417	373	379
Bell pepper	NA	NA	NA	833	949	1,542	477	470	633	658	794	NA
Cantaloupe	NA	NA	NA	1,833	3,825	6,448	6,331	4,430	2,497	1,406	426	NA
Carrots	2,651	1,385	1,709	1,634	1,538	1,412	1,037	860	973	1,063	1,138	1,297
Greens	644	676	943	852	700	222	226	202	290	326	332	747
Leaf lettuce	NA	NA	93	67	52	26	33	34	30	27	68	164
Potatoes	NA	NA	NA	15,623	16,400	9,713	8,416	9,192	9,149	9,937	NA	NA
Tomatoes	NA	NA	NA	NA	4,634	12,750	6,060	2,187	2,564	3,241	3,087	NA

Note: Actual market shares for snap beans, cucumber, greens, and tomatoes exceed 10% in certain months. Production may occur in any of the four regions of the study area given profitability and climate restrictions where NA indicates infeasibility of production given such restrictions.

[a]Solution values for the vegetable crops did not vary with respect to the base versus a simulated 20% decrease in the demand for row crops.

Base Solution

In a comparative static analysis, a common base is needed against which alternative scenarios may be compared. In order to obtain a base solution, the quadratic programming model was used to track, as closely as possible, actual cropping patterns of the row crops in the study area. Acreage of most of the fresh vegetable crops grown in the study area is not definitively known.

The tracking procedure began by adjusting the intercepts of the price-quantity demand functions for the row crops by the difference between the solution price obtained from the model and the actual average price for the study area from 1980–1984 where such differences existed. This was deemed appropriate in order to reflect declining demand for major farm commodities after 1981.

Further alterations needed to obtain the base solution involved trial-and-error adjustments to production costs. Dual values of activity levels obtained from temporarily constraining crop acreage to actual acreage were used to guide the trial-and-error process.

RESULTS

A summary of the results of the comparative static analysis is conveyed in Tables 2–4. Table 2 shows the effects of alternative market shares of fresh vegetable commodities on acreage of selected vegetable and row crops in the study area. The impacts of different simulated demands for row crops are also included in this table. Effects by region of the study area are not shown because of space limitations. Fresh vegetable production by harvest month and simulated demand for the row crops, assuming a 10 percent market share for the fresh vegetables, is presented in Table 3, while Table 4 illustrates the partial equilibrium welfare changes with respect to alternative market shares for the fresh vegetables in relation to the different simulated demands for row crops in the study area.

Base solution acreages represent the foundation against which acreages associated with each simulated fresh vegetable market share and row crop demand are compared. In order to provide an anchor for base solution acreages, actual acreages of vegetable crops and row crops are presented in Table 2.[8]

As shown in Table 2, fresh vegetable crops utilize relatively few acres compared to row crops even assuming a 20 percent market share for fresh vegetables and a 20 percent decrease in the demand for row crops. By the same token, reductions in acreage of fresh vegetables are minor for all market shares shown in Table 2 given a 30 percent increase in the demand for the row crops.

As shown in Table 3, with the vast diversity of climates in the study area, production of vegetables is possible eight to 12 months of the year. Planting and harvesting dates provided by biological scientists serve as the foundation for the results depicted in Table 3. The climatically fringe possibilities embedded in Table 3 are being tested empirically. With a 30 percent increase in demand for the row crops, minor reductions in fresh vegetable production are apparent primarily in the summer months in Table 3.

Relative to the base solution, the value of the objective function, which represents net social payoff or welfare, increases dramatically as market share for fresh vegetables increases, Table 4. Even with a 20 percent decrease in demand for the row crops, a 10 percent market share for fresh vegetables can more than offset welfare losses attributable to declining row crop demands. Certainly, increases in the value of net social payoff are most dramatic with both increasing market share for fresh vegetables and increasing demands for row crops. Such comparisons, which were employed in a similar vein by Adams et al., must be considered in light of the assumptions behind the analysis which in this case is a normative partial equilibrium analysis. Nevertheless, the magnitudes of the changes in the welfare function seem compelling.

TABLE 4. COMPARISON OF VALUES OF THE WELFARE FUNCTION (NET SOCIAL PAYOFF), BASE MODEL SOLUTION, AND SOLUTIONS WITH ALTERNATIVE MARKET SHARES FOR FRESH VEGETABLE CROPS BY SIMULATED ROW CROP DEMAND

Model Scenario	Value of Welfare Function (NSP)	Difference	
		Value[a]	Percentage[b]
	(1,000 dollars)	(1,000 dollars)	
Base model	942,063	—	—
Base level demand for row crops			
Market share			
1%	995,243	53,180	5.64
5%	1,233,403	291,340	30.92
10%	1,545,898	603,835	64.10
20%	2,191,928	1,249,865	132.67
20% decrease in demand for row crops			
Market share			
1%	604,554	−337,509	−35.83
5%	842,752	−99,311	−10.54
10%	1,155,171	213,108	22.62
20%	1,801,102	859,039	91.19
30% increase in demand for row crops			
Market share			
1%	1,957,909	1,015,846	107.83
5%	2,194,742	1,252,679	132.97
10%	2,505,153	1,563,090	165.92
20%	3,146,913	2,204,850	234.04

[a]Value Difference = Market Share Solution Value—Base Model Value.

[b]Percentage Difference = (Value Difference/Base Model Value) 100.

[8]In actuality, acreages for the vegetable crops are imputed because acreage data for vegetables by season are not generally available for the tri-state area. Yield estimates from extension budgets were used to convert quantities to acres.

CONCLUSIONS

As reflected in this paper, it seems clear that vegetable crops are not destined in the near future to replace row crops in terms of land utilization. Nevertheless, vegetable crops appear to compete with and complement row crops well, as evidenced by substantial increases in production as market share was assumed to increase.

Empirical evaluation that is now under way may show that the production potential of vegetables in the study area is not as great as depicted in certain climatically fringe months. As data become available, variability in yield or gross returns may be better measures of variation for the risk coefficient.

Though vegetables do not utilize large acreages of cropland, the dramatically increasing value of the welfare function with an increasing market share clearly signals the importance of fresh vegetables as possibly profitable enterprises in the study area. However, it also is clear that production of fresh vegetables cannot be considered as residual enterprises to which producers move when the levels of demand for row crops decline. The results of the analysis showed that even with a 20 percent decrease in the demand for row crops, the acreage of fresh vegetables did not increase. Obviously, if fresh vegetable production is to be pursued, increasing market share is the appropriate goal regardless of the changing fortunes of row crop production.

The realization of greater market shares for vegetables in the study area goes beyond the scope of this paper. Greater market shares are likely to depend on spatial comparative advantage and the entrepreneurial spirit of agricultural producers in the study area. Indeed, market shares for fresh vegetables in the study area have been increasing slowly since the early 1970s.

Because of the increasing value of the welfare function with simulated increases in market share for fresh vegetables, a policy implication regarding the use of public research funds to discover and develop potentially profitable alternative vegetable crops by region of the United States may be forthcoming. That is, such funds perhaps should be devoted to the discovery of vegetable crops for which market share may be increased as a result of location, climate, and natural resources and to research which would be oriented toward enhancing such advantages within the confines of economic efficiency. Certainly, this approach would require a well-coordinated, interdisciplinary research thrust. Such a strategy for the use of public research funds perhaps may be generalized to other agriculture diversification programs.

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