Richard L. Kilmer
Thomas H. Spreen

Economic Information
Report 180

Indian River Citrus Packinghouses and the Southward Movement of Production

Food and Resource Economics Department
Agricultural Experiment Stations
Institute of Food and Agricultural Sciences
University of Florida, Gainesville 32611

April 1983

ABSTRACT

Existing packinghouses are located near older groves. As more citrus is grown farther south in Florida, transportation cost increases will occur unless new packinghouses open near the new production areas. This paper is concerned with the impact of the southern movement of citrus production in the Indian River marketing district on the size, number, and location of citrus packinghouses.

The southern movement of citrus production does suggest the need for construction of a new packinghouse in Jupiter, Florida. Existing packinghouses could be reconfigured into larger packinghouses. In general, however, the Indian River packinghouse capacity is located where the production is located.

Key words: Grapefruit, Indian River, oranges, packinghouses, plant location.

ACKNOWLEDGEMENTS

We wish to express our appreciation to Mr. George Kmetz, formerly with the Indian River County Appraisers office, for his assistance in determining the building costs for Indian River packinghouses and to the Florida Department of Citrus for financial assistance.

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INTRODUCTION

The Indian River area is a marketing order district on the east coast of Florida (Figure 1). Nearly two-thirds of its western border is separated from the Interior marketing district by swampland that contains little or no citrus. In the past 15 years, new plantings have been concentrated in the southern half of the district. The projected growth in grapefruit and orange production from 1979-80 to 1983-84 is 12.3 percentage points greater in the southern production area (Figure 1) than in the northern area (26.9 and 14.6 percent, estimated from Florida Crop and Livestock Reporting Service, 1980 and Fairchild). Existing packinghouses are located near older groves. As more citrus is grown farther south, transportation cost increases will occur unless new packinghouses open near the new production areas.

PROBLEM STATEMENT

The problem to be examined in this study is concerned with the impact of the southern movement of citrus production (Figure 2) in the Indian River marketing district on the size, number, and location of citrus packinghouses.

RICHARD L. KILMER and THOMAS H. SPREEN are assistant professor and associate professor of food and resource economics.

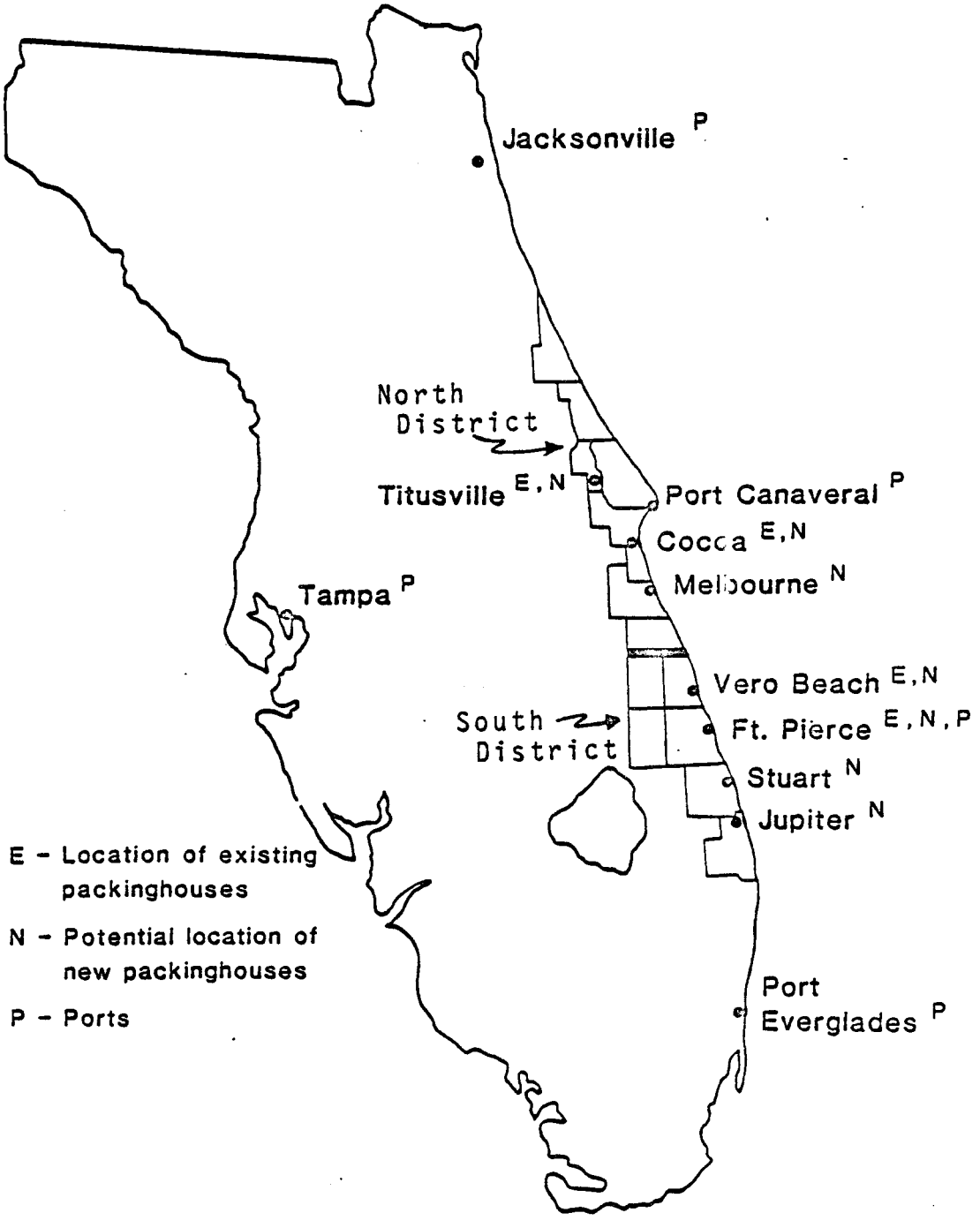

Figure 1.—Indian River district grapefruit and orange production, packinghouses and ports for fresh fruit

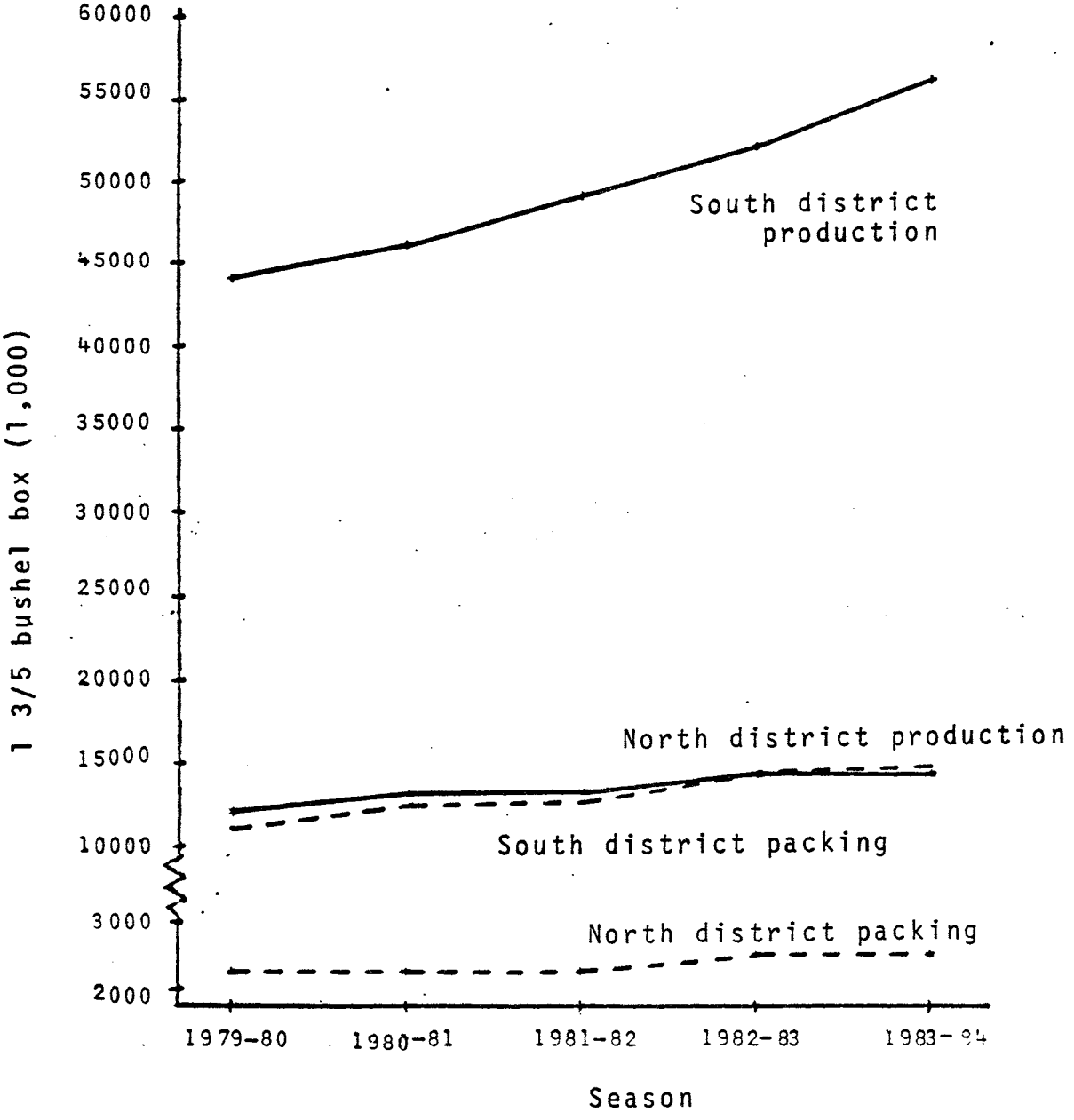

Figure 2.—Indian River marketing district projected production and packing of oranges and grapefruit, 1979 - 80 through 1983 - 84

Overview of the Study

An analytical approach to this study is to identify a number of supply points representing groups of groves and a number of demand points or "destinations". In this study, demand points are regions of the U.S., Canada, and five possible ports of export (see Figure 1). In 1979, there were 35 existing plants in four locations. These plants are divided into two groups designated as small (under 500,000 1 3/5 bushel boxes) and large (over 500,000 boxes). Only large new plants are considered and are allowed to open at the four existing locations and three new locations (see Figure 1). Using estimates for the cost of shipping fruit from the supply points to the packing plants (the assembly problem), the cost of shipping fruit from the plants to the demand points (the distribution problem), and the cost of packing the fruit at the packing plants, the best configuration (size, number and location) of the plants is determined by that configuration which allows assembly, packing, and distribution of the fruit at least cost.

The optimal configuration for a particular crop year can be determined via a mixed integer programming model. Using the computer, total assembly, packing, and distribution cost associated with each feasible configuration,[1] the least cost configuration is determined.

The mixed integer programming model gives the optimal configuration for a given crop year, but does not indicate how the industry can best adjust from the existing configuration to another one. This problem is not trivial since there are costs associated with opening new plants and closing old plants called transition costs. To find the optimal path of adjustment from the existing configuration to a new configuration, a dynamic programming model is used. A mixed integer programming model determines the best plant configuration for a particular crop year.

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[1]A feasible configuration is one in which the plants have sufficient capacity to pack all of the fruit available.

This solution is excluded and the model is run again to find the second best configuration.

The process is repeated until several solutions are formed. In this study, the crop years 1979-80 through 1983-84 are each analyzed in this manner. Using dynamic programming, the optimal path is found beginning with the existing configuration through the 1983-84 crop year which minimizes the sum of assembly, packing, and distribution costs over these years plus the transition costs incurred as new plants open and old plants close.

For a technical description and justification of the particular methodology used, see Kilmer, Spreen, and Tilley. The remainder of this report is to document the data used in the analysis and to report the results.

DATA FOR MODEL

Supply and Demand

Oranges and grapefruit represented 97 percent of the citrus packed in the Indian River marketing district during the 1979-80 marketing season (Florida Department of Agriculture and Consumer Services, 1980, p. 37). In order to project the future production of oranges and grapefruit by supply area, tree data by age and variety (Florida Crop and Livestock Reporting Service, 1980) are combined with yield information by tree age and variety (Fairchild, 1977, pp. 24-32) (Table 1). The varieties are early and midseason oranges, 'Valencia' oranges, 'Temple' oranges, seedy grapefruit, white seedless grapefruit, and pink seedless grapefruit. The Indian River marketing district shipped 6.8 and 67.1 percent of the oranges and grapefruit harvested to packinghouses in 1979-80 (calculated from the Florida Crop and Livestock Reporting Service, 1981, p. 28, and Florida Department of Agriculture and Consumer Services, 1980, p. 37). Even though oranges and grapefruit are brought to a packinghouse, only 65.6 and 76.1 percent of the deliveries

Table 1.--Projected production of oranges and grapefruit in the Indian River marketing district, 1979-80 and 1983-84 seasons

Location	1979-80		1983-84	
	Oranges	Grapefruit	Oranges	Grapefruit
	1 3/5 bushel box			
North[a]	8,699,047	3,529,207	9,957,905	4,055,227
South[a]	24,022,998	19,756,592	29,739,736	25,824,685

[a]See Figure 1 for location.

were actually packed during the 1979-80 season (Hooks and Kilmer, 1981a, p. 4). The remainder was shipped to processing plants. Total one and three-fifths bushel boxes packed in the Indian River marketing district are projected for the 1979-80 through the 1983-84 marketing seasons (Figure 2), after considering tree age, variety, yield, and the percentage of citrus taken to the packinghouse which was actually packed.

The projected oranges and grapefruit packed are either exported (1.7 and 40 percent) or shipped intra and interstate (98.3 and 60 percent--Florida Department of Agriculture and Consumer Services, 1980, pp. 33-34). North America is divided into five demand areas with central points for distribution at New York City, Atlanta, Chicago, Los Angeles, and Toronto, Canada (Table 2). Each region is assumed to maintain its 1979-80 market share for oranges and grapefruit through 1983-84 (Florida Department of Citrus, 1980) (Table 2). Fresh citrus is exported through Ft. Pierce, Jacksonville, Port Canaveral, Port Everglades, and Tampa, all in Florida (Table 2). The 1979-80 market share (Table 2) for each port is assumed to remain unchanged through the 1983-84 marketing season (Florida Department of Agriculture and Consumer Services, 1980, p. 35).

Assembly and Distribution Costs

The distribution costs (Table 3) from packinghouses in the Indiana River district to the five North American cities (already identified) are determined by averaging actual quoted rates for oranges and grapefruit from November 1979 through May 1980 (U.S. Federal-State Market News Service). The distribution cost per one and three-fifths bushel from the packinghouses to the ports is equal to .2049 plus .0041 times one-way distance in miles (Updated Machado, 1978, p. 100, to 1979-80 dollars). The cost of hauling the oranges and grapefruit from the citrus groves to the packinghouses and the cost of hauling eliminations from the packinghouse to a processing plant is $.00727 per one and three-fifths bushel mile (calculated from Hooks and Kilmer, 1981b, p. 7).

Table 2.--Projected disposition of Indian River fresh citrus shipments, 1979-80 season

Location	Oranges		Grapefruit	
	----------1 3/5 bushel box----------			
Domestic regions				
Atlanta	428,255	(30%)	891,838	(13%)
Chicago	265,607	(19%)	1716,664	(24%)
Los Angeles	139,943	(10%)	655,156	(9%)
New York	474,522	(33%)	3,011,292	(42%)
Toronto	119,666	(8%)	854,054	(12%)
Subtotal	1,427,993	(100%)	7,129,004	(100%)
Port of exit				
Ft. Pierce	7,049	(28%)	1,334,315	(28%)
Jacksonville	1,664	(7%)	315,020	(7%)
Port Canaveral	3,535	(14%)	669,061	(14%)
Port Everglades	3,575	(14%)	676,675	(14%)
Tampa	9,317	(37%)	1,763,542	(37%)
Subtotal	25,140	(100%)	4,758,613	(100%)
TOTAL	1,453,133		11,887,617	

Table 3.--Estimated fresh citrus truck hauling costs per 1 3/5 bushel, 1979-80 season

	Cost	
	Oranges	Grapefruit
Atlanta	$1.09	$1.01
Chicago	2.72	2.67
Los Angeles	4.88	4.58
New York	2.72	2.67
Toronto[a]	3.24	3.18

[a]Toronto was estimated by taking the rate to New York times 1.19 to account for the extra distance to Toronto.

Source: U.S. Federal-State Market News Service.

Packing Costs

Existing packinghouse capacities over time are assumed to be the 1979-80 volume packed plus 20 percent[2] (Florida Department of Agriculture and Consumer Services, 1980, pp. 18-24). Existing plants were categorized as small (100,000 to 500,000 one and three-fifths bushels annually) or large (500,001 to 850,000). All new plants are assumed to be large plants.

The variable costs for existing and new packinghouses includes labor (less 30 percent of the foreman labor that is assumed fixed), direct operating expenses less repairs and maintenance, 30 percent of the administration expense, and 50 percent of the sales expense (Table 4). Fixed costs for existing plants are composed of overhead and

[2]Packinghouse capacity figures are not available; therefore annual volume packed was used. Kilmer and Tilley found that Florida packinghouses operate at an 11 month average of 50 percent of capacity. Capacity utilization for some individual plants will be greater than 50 percent. Thus, the potential individual packinghouse capacity is assumed to be 20 percent greater than the volume packed by each packinghouse in 1979-80.

investment servicing cost (debt servicing plus net return on investment). Overhead includes repairs and maintenance, insurance, taxes and licenses, 30 percent of foreman labor, 70 percent of administrative expense, and 50 percent of sales expense (Table 4). Investment servicing cost is $.125 per one and three-fifths bushel (calculated from Hooks and Kilmer, 1981a, and Florida Department of Agriculture and Consumer Services, 1980, p. 37).[3]

Table 4.--Estimated variable and fixed costs per 1 3/5 bushel box, 1979-80 season

Cost	Packinghouse	
	Small[a]	Large[a]
Variable		
Materials	$1.068	$ .975
Labor (.70)	.900	.743
Direct operating	.104	.120
Administrative (.30)	.074	.052
Sales (.50)	.081	.118
Total variable cost	$2.227	$2.008
Fixed		
Labor (.30)	.078	.062
Repairs and maintenance	.251	.112
Insurance	.054	.028
Taxes and licenses	.019	.024
Administrative (.70)	.172	.123
Sales (.50)	.081	.118
Total fixed cost	$ .655	$ .467

[a]Small is 100,000 to 500,000 1 3/5 bushel box annual volume; large is 500,001 to 850,000 1 3/5 bushel box annual volume.

Source: Packinghouse records.

[3]The $.125 figure is taken from accounting records and is labelled as depreciation and rent. Data on actual debt servicing and net return on investment are not available. Ideally, this information is needed from each packinghouse.

The same estimate of overhead for existing plants is used for new plants. Using data provided by Kmetz (1982), total estimated facility costs for a new large plant in 1980, including land, building, offices, and equipment, was $1.7 million (Table 5). It is assumed that a 20 percent downpayment of $340,000 would be required, the remainder financed at 16 percent for 20 years. The annual debt servicing costs are $229,387. The downpayment, $340,000, represents net investment. Since all costs are in constant 1979 dollars, a real rate of return (nominal interest rate minus the inflation rate) on net investment of 3 percent is assumed. The downpayment is a fixed cost but also can be viewed as a transition cost, since it is a cost which is incurred only in the year the plant opens.

Table 5.--Estimated land, packinghouse, equipment, and working capital cost in the Indian River marketing district, 1980 dollars

Item	Packinghouse[a]	
	Small	Large
Land[b]	$ 63,000 (6 acres)	$ 105,000 (10 acres)
Packinghouse building, metal, dock height[b]	$ 346,892 (28,571 sq.ft.)	$ 607,000 (50,000 sq.ft.)
Packinghouse equipment[c]	$ 230,053	$ 314,053
Fork lifts[b]	$ 48,000	$ 72,000
Office building[b]	$ 63,839 (3,000 sq.ft.)	$ 85,120 (4,000 sq.ft.)
Office equipment[b]	$ 44,889	$ 44,889
Operating capital[d]	$ 210,500	$ 421,000
	$1,007,173	$1,649,062

[a]Each packinghouse has a central sizer, packer aids, no mechanical palletization, and no cold storage.

Source: b.--Kmetz, 1982; c.--Industry source; d.--Packinghouse records.

Other Assumptions

Once a new plant is opened, it is not allowed to close. An existing plant which covers cash costs but not all investment servicing costs is closed after three years. If existing plant is closed for less than three years, it can re-open at zero start-up cost. A look at the past industry adjustments in number of packinghouses actually in operation from one season to another reveals an industry able to make short-term adjustments in numbers. From the 1964-65 season to 1965-66, packinghouse numbers increased from 160 to 225 (State of Florida total -- Florida Department of Agriculture and Consumer Services). By the 1968-69 season, the number of packinghouses declined to 169. A similar decrease occurred from 1969-70 season until 1971-72 when the number of packinghouses declined from 211 to 164.

RESULTS

The model includes oranges and grapefruit produced in 13 locations in the Indian River district of Florida, 35 existing packinghouses at four locations, potential opening of new packinghouses at three locations where no packinghouses currently exist (Figure 1), five consumption regions in the U.S. and Canada (Table 2), and five export points (see Figure 1 for the Florida locations).

The static mixed integer solutions for 1979-80 through the 1983-84 seasons are obtained from a mixed integer plant location model which contained small and large existing packinghouses and large new packinghouses. The costs associated with the best solutions are shown in Table 6. The costs have been discounted to 1979 using a 3 percent real discount rate (without inflation). The costs in 1983-84 are adjusted to reflect the present value of the cost of packing citrus from 1983-84 on indefinitely, assuming that configuration and supply and demand levels remain unchanged. Using estimated discounted transition costs (Kilmer, Spreen, Tilley) and the static solutions from the mixed integer program-

Table 6.--Static and dynamic solutions to the packinghouse location problem, 1979-80 through 1983-84[a]

Rank ordered solutions	Dynamic program solution	Static solutions for seasons				
		1979-80	1980-81	1981-82	1982-83	1983-84 (through infinity)[b]
	thousand $					
1	2,548,660 (Best)	59,083	60,762	62,799	64,829	66,901 (2,296,922)
2	2,548,982 (Fourth Best)	59,083	60,782	62,807	64,832	66,911 (2,297,276)
3		59,094	60,838	62,821	64,863	66,914 (2,297,396)
4		59,101	60,852	62,826	64,865	66,925 (2,297,750)
5		59,109	60,862	62,900	64,882	67,001 (2,300,387)
6		59,118	60,877	62,907	64,884	67,012 (2,300,741)
7		59,139	60,884	62,919	64,904	67,015 (2,300,831)
8		59,146	60,922	62,920	64,924	67,025 (2,301,186)
9		59,152	60,939	62,941	64,926	67,025 (2,301,186)
10		59,176	60,943	—	64,977	67,046 (2,301,896)
Initial configuration	2,605,366	62,350	63,687	65,167	66,779	68,371 (2,347,383)
Transition cost (Best)		2903[c]	365	320	329	302
Transition cost (Fourth best)		2903[c]	365	320	329	302
Transition cost (Initial conf.)		0[c]	0	0	0	0

[a]All costs are in 1979 dollars.

[b]Present value of collection, packing, and distribution cost from 1983-84 to infinity, assuming plant configuration, supply, and demand remain unchanged.

[c]Transition cost to initial configuration.

ming model, dynamic solutions to the packinghouse location problem are obtained and two such solutions are shown in Table 6. The solid underlined elements represent the least cost path over time. The dashed underlined elements represent the fourth least cost path over time.

The best solution in 1979-80 calls for the immediate closing of 24 existing plants (11 remain open) and building six large plants for a total of 17 plants (Table 7). By the 1983-84 season, nine existing houses are still operating. One of the new packinghouses is located at Jupiter in the southern part of the region (Figure 1) where no existing packinghouses are located. By employing the dynamic solution for packinghouses instead of allowing the initial plant location and relative sizes to exist over time, the packinghouses in the Indian River market

Table 7.--Packinghouse size configuration for the best dynamic solution

Location	Capacity (1-3/5 bu. box)	Initial configuration	Packinghouse number for seasons				
			1979-80	1980-81	1981-82	1982-83	1983-84
	1,000s						
North							
Titusville	100-500	2*	-	-	-	-	-
	501-850	-	1	1	1	1	1
Cocoa	100-500	1*	1*	1*	1*	-	-
	501-850	-	-	-	-	-	-
Melbourne[a]	501-850	-	-	-	-	-	-
South							
Vero Beach	100-500	11*	1*	-	-	-	-
	501-850	7*	7*,1[b]	7*,2	7*,3	7*,3	7*,4
Ft. Pierce	100-500	12*	-	-	-	-	-
	501-850	2*	2*,3	2*,3	2*,3	2*,4	2*,4
Stuart[a]	501-850	-	-	-	-	-	-
Jupiter[a]	501-850	-	1	1	1	1	1

[a]New location.

[b]7*, 1 means seven existing plants operating and one new plant operating in that year.

district could save $56,706,000 (1979 dollars) or 2.2 percent of the best dynamic solution. During 1983-84 alone, total assembly, packing, and distribution costs could be reduced by $1,470,000 or $.086 per one and three-fifths bushel box (1979 dollars).

Finally, most of the existing packinghouses close in the first season, 1979-80. This is not unusual and is entirely feasible (See other assumptions).

SUMMARY AND CONCLUSIONS

The southern movement of citrus production does suggest the need for construction of a new packinghouse in Jupiter, Florida, which is located in the southern part of the Indian River marketing district. Existing capacity could be reconfigured into larger packinghouses. Instead of building new plants in the same cities where old (existing) plants are located, the old packinghouses could be enlarged to take advantage of economies of size. In general, however, the Indian River packinghouse capacity is located where the production is located. Total collection, packing, and distribution costs could be reduced by only 2.2 percent if the industry closed all small packinghouses and maintained and built new packinghouses. Only the cost side of the packinghouse industry, however, is explored in this study. Small packinghouses that pack for a select market may be quite profitable. Also, a small packinghouse may have management that is just as cost efficient as a large packinghouse. Thus the southerly shift in citrus production will have a small effect on existing packinghouse size and location over the next decade; however, a new packinghouse is needed in the southern portion of the district.

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