Fresh Versus Processed Utilization of Florida Grapefruit

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The allocation problem of sending grapefruit to packinghouses versus processing plants is considered in this paper. The authors examine on-tree grower prices reported by the USDA for fresh and processed grapefruit and report that these prices do not reflect the alternative returns necessary for this allocation decision. The USDA processed on-tree price is a weighted average of returns for fruit that is intended for processing and fruit that is not intended for processing while the USDA fresh on-tree price is for fruit that is only intended for the fresh market.

Introduction

In recent years, Florida grapefruit growers have been experiencing low returns. In the 1997–98 season, the Florida grapefruit on-tree price for all fresh and processed utilized fruits was $1.27 per box (FASS, 1998a) while the average cost of production ranged from $2.94 per box for fruit grown for the processed market to $3.60 per box for fruit grown for the fresh market,[1] based on cost estimates by Muraro et al. (1998a, 1998b). This situation follows a number of profitable seasons during the 1980s and early 1990s when crops were smaller and prices were higher (Table 1). The Florida grapefruit on-tree price was $5.66 per box in 1990–91 and $6.62 per box in 1991–92, before decreasing sharply to $2.66 per box in 1992–93. The on-tree price recovered somewhat to $3.28 per box in 1993–94 and then decreased to $2.09 in 1994–95; thereafter, the price has steadily fallen.

Florida's grapefruit production was adversely impacted by several freezes in the 1980s and in the 1989–90 season. High prices during this period stimulated tree plantings, eventually resulting in much larger crops and returns below cost. The present unprofitable grapefruit situation has resulted in some exit from the industry, with grapefruit tree numbers and acreage declining slightly by 1.5 percent and .3 percent, respectively, from 1996 to 1998 (FASS, 1998b). This small reduction of trees and acres, however, may not result in significantly smaller crops and improved prices in the future, as the tree population is still relatively young and has the potential to yield larger crops through tree maturation alone (FDOC, 1999). Additional acreage reductions, as well as reduced grove care, may limit crop sizes and result in improved prices, but with grower investments in trees being large and few alternative land uses, tree removal may not be sufficient to result in prices that cover grower costs in upcoming years.

Some growers near urban areas may be able to sell their groves at good prices for commercial or residential development, but growers in other areas may not have viable alternatives for their land. Any single grower may have expectations that present low returns could result in other growers exiting the industry, leading to decreased production and eventual higher, profitable prices. To the extent that such expectations exist, many growers may choose to remain in the grapefruit business, and the adjustment process to improved prices could be slow, lasting perhaps a number of years.

During a period of potentially prolonged low returns, grapefruit growers that can best take advantage of market opportunities are more likely to survive. One area in which there may be opportunity is the allocation of fruit between fresh and processed uses. Fruit can be directly sent from the

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[1]On-tree prices and costs can vary significantly between growers. For example, growers with older groves in some regions may obtain high yields or boxes of fruit per acre, driving cost-per-box substantially below the industry average costs discussed in this paper. Likewise, some growers may have long-term contracts or may belong to cooperatives that provide processing of on-tree returns that are higher than the average processed on-tree prices discussed here.

Table 1. Florida Grapefruit On-Tree Prices for All Uses.

Season	White Seedless	Red Seedless	Seedy	Combined
		$/box		
1980–81	3.46	4.22	2.92	3.60
1981–82	1.92	2.80	1.13	2.09
1982–83	1.51	3.20	.70	1.96
1983–84	2.08	4.05	2.01	2.72
1984–85	3.02	4.84	2.58	3.67
1985–86	3.56	4.98	3.27	4.09
1986–87	4.45	5.80	4.27	4.98
1987–88	5.35	5.93	4.99	5.57
1988–89	4.33	4.71	3.68	4.45
1989–90	5.21	6.30	3.84	5.65
1990–91	4.59	6.85	3.93	5.66
1991–92	6.46	6.87	4.57	6.62
1992–93	2.22	3.11	1.88	2.66
1993–94	3.23	3.38	1.78	3.28
1994–95	2.58	1.66	2.03	2.09
1995–96	2.14	1.77	1.73	1.93
1996–97	1.12	1.91	.13	1.55
1997–98	.93	1.50	.12	1.27

Source: FASS (1998a).

field to packinghouses (desired fresh utilization) or processing plants (field-run processed utilization). A portion of the fruit sent to packinghouses will not meet fresh standards; this fruit is called eliminated fruit, or eliminations. Normally, this fruit will be sent to processing plants. (Eliminations may also be discarded, depending on processor demand.) The percentage of fruit sent to packinghouses that meets fresh standards and is shipped fresh is referred to as the pack-out rate. Along with prices for fresh and processed grapefruit products, the pack-out rate is critical to grower returns.

Fresh and processed prices are influenced by a number of factors, including fruit size, external appearance, sweetness and other attributes of juice quality. During the harvesting season, growers have little influence over these factors; weather and earlier grove care decisions largely determine fruit quality although harvesting can be delayed to allow fruit to mature and its sugar content to increase. Growers make long-run decisions during the grove care period by giving fruit that is planned for the fresh market additional care (application of chemical sprays for various citrus pests). Fruit that does not receive such care, however, may still be suitable for the fresh market and utilized as such, depending on growing conditions and the fresh-processed demand situation.

In the remainder of this paper, the impact of pack-out rates on grower returns and a review of recent historical data on grower prices are presented. Pack-out rates are related to grading stan-

dards, crop quality, fresh utilization rates, and the extent that growers selectively pick high-quality fruit. Grading standards and, to a considerable extent, crop quality are exogenous, determined by state law and weather, respectively. Although fruit quality can be partially controlled by grove care practices, pack-out rates also tend to be negatively related to fresh utilization rates, with those boxes of fruit that have the highest likelihood of making grade being the first sent to packinghouses, followed by boxes with a lower likelihood of making grade. Growers can affect these probabilities through selective picking. In a recent study, Hollander, Monier-Dilhan, and Ossard (1999) examined factors affecting grading, finding that high-quality producers tend to grade less than low-quality producers and that market structure impacts grading (a competitive industry carries out an optimal amount of grading). The present study differs from that study in that all growers must have their fruit graded for the fresh market although several different grade levels exist. We focus on potential grapefruit grower opportunities due to differences in returns for fruit sent to packinghouses versus fruit sent to processing plants.

Grower Returns

The approach used in this paper to analyze grapefruit grower returns is based on the USDA (FASS, 1998a and other issues) approach to calculating grower on-tree returns per box. First, the USDA calculates packinghouse-door (PHD) values for (1) fresh utilization—fruit delivered to packinghouses and eventually sold as fresh fruit (roadside sales of fresh fruit are also included)—versus (2) processed utilization—fruit delivered to processing plants, including fruit directly from the field and eliminations from packinghouses. PHD values per box are prices that growers receive for fruit delivered to packinghouses or processing plants. These prices are reported in various issues of *Agricultural Prices* and *Citrus Fruits* (NASS, various issues of annual summaries). Next, the USDA calculates pick-and-haul costs—the costs associated with harvesting the fruit and transporting it to packinghouses or processing plants. Pick-and-haul costs for three groups of fruit are calculated—(1) fresh utilization, (2) packinghouse eliminations, and (3) fruit sent directly from the field to the processing plant (field-run). The cost of eliminating fruit at packinghouses and sending it to processing plants is also calculated. The USDA then calculates fresh on-tree returns, or the value of fruit on the tree, by subtracting pick-and-haul costs for fresh utilization from the PHD value for this group; it also calculates processed on-tree returns by subtracting elimination costs and pick-and-haul costs for field-run and eliminated fruit from the PHD value for processed utilization.

Note that the inclusion of eliminated fruit with field-run fruit in calculating processed returns is arbitrary, as eliminated fruit could be alternatively included with fresh utilization to calculate returns for fruit sent to packinghouses versus fruit sent to processing plants. Knowledge of such alternative returns are needed to determine the optimal allocation of fruit between packinghouses and processing plants. Assuming profit maximization, growers would send fruit where the return is highest, and assuming competitive behavior[2] and negative price-quantity relationships at packinghouses and processing plants, an equilibrium would be reached when the return associated with fruit sent to the packinghouse equals the return realized for fruit directly sent to the processing plant. (At some points in a season, all of the harvested fruit is sent to either packinghouses or processing plants, as subsequently discussed.)

Formally, let the average PHD prices for fresh and processed utilization be p_1 and p_2, respectively; let the average pick-and-haul costs for fruit sent to packinghouses versus processing plants be c_1 and c_2, respectively; and let the average elimination cost be c_3. Denote the number of fresh and processed boxes utilized by q_1 and q_2, respectively. Let the number of processed boxes that come directly from the field be denoted by q_{21} and the number of processed boxes that come from eliminated fruit be denoted by q_{22} so that q_2

[2]The Florida fresh fruit packing industry appears to exhibit a competitive structure, with 123 packinghouses in 1997–98 (Division of Fruit and Vegetables, Florida Department of Agriculture & Consumer Affairs) and about 2,889 grapefruit growers (U.S. Department of Commerce, 1992 Census of Agriculture). Of the 123 packinghouses, 116 packed grapefruit, with the largest packinghouse (four largest packinghouses) accounting for 5.2 percent (16.9 percent) of the total grapefruit packed in the state.

$= q_{21} + q_{22}$. Lastly, define $v=q_{21}/q_2$, or the share of processed fruit that is field-run, and $1\text{-}v = q_{22}/q_2$, or the share of processed fruit from packinghouse eliminations. Data on c_1, c_2, c_3, q_1, and q_2 are reported, but data on q_{21}, q_{22}, or v are not. Below, we show how estimates of these unreported variables can be made and used in analyzing the fresh-processed allocation decision.

Note that the reported USDA fresh and processed on-tree prices, indicated by f_{ot} and p_{ot}, respectively, can be written as

$$f_{ot} = p_1 - c_1, \tag{1}$$

and

$$p_{ot} = (p_2 - c_2)\, v + (p_2 - c_1 - c_3)\,(1\text{-}v), \tag{2a}$$

or after rearranging terms,

$$p_{ot} = p_2 - (c_2\, v + (c_1 + c_3)\,(1\text{-}v)). \tag{2b}$$

USDA on-tree prices, f_{ot} and p_{ot}, as defined in equations (1) and (2), do not reflect the trade-off, of sending fruit to packinghouses versus processing plants, that confronts growers. An important variable underlying this trade-off is the pack-out rate, which we denote by *w* (the share of fruit sent to packinghouses that makes grade and is shipped fresh). Historical pack-out rates are not published but can be derived from published data as follows. First, define the difference between PHD and on-tree prices for processed fruit as $d = p_2 - p_{ot}$, or given result (2b), as

$$d = c_2\, v + (c_1 + c_3)\,(1\text{-}v). \tag{3}$$

The term *d* is a weighted average cost of processed pick-and-haul costs (c_2) and fresh pick-and-haul costs (c_1) plus elimination costs (c_3), with the weights being *v* and (1-v), respectively.

Solving (3) for *v* gives

$$v = (d - c_1 - c_3) / (c_2 - c_1 - c_3). \tag{4}$$

Given values for the terms on the right-hand side of (4), *v* can be estimated.

In turn, given an estimate of *v*, eliminations can be estimated by $(1\text{-}v)\, q_2$; fruit sent to packinghouses can be estimated by $q^*_1 = q_1 + (1\text{-}v)\, q_2$; and the pack-out rate can be estimated as

$$w = q_1 / q^*_1 . \tag{5}$$

Next, consider the on-tree price relationship for fruit sent to packinghouses versus fruit sent to processing plants. The weighted average on-tree price for fruit sent to the packinghouse is

$$ot_1 = (p_1 - c_1)\, w + (p_2 - c_1 - c_3)\,(1\text{-}w). \tag{6}$$

In comparison, the on-tree price for field-run fruit sent to the processing plants is

$$ot_2 = p_2 - c_2 . \tag{7}$$

Note the reverse treatment of the price term for eliminations $(p_2 - c_1 - c_3)$ in equations (6) and (7) versus equations (1) and (2a). In equation (6), the fresh on-tree price term $(p_1 - c_1)$ and the on-tree price term for eliminations $(p_2 - c_1 - c_3)$ are weighted by *w* and (1-w), respectively, to obtain a weighted average per-unit return associated with fruit that is initially sent to the packinghouse, with the on-tree price for field-run fruit given separately by equation (7); in contrast, the USDA reports the fresh on-tree price separately (equation (1)), and the weighted average of the field-run on-tree price term and the on-tree price term for eliminations, using weights *v* and (1-v), respectively (equation (2a)). Equations (6) and (7) indicate alternative returns for allocating grapefruit to packinghouses versus processing plants while equations (1) and (2a) do not.

For profit maximization under perfect competition, the return at the packinghouse would be expected to equal that at the processing plant or $ot_1 = ot_2$. When $ot_1 > ot_2$, profit can be increased by sending more fruit to packinghouses. (The opposite would be expected when $ot_1 < ot_2$.) As more fruit is sent to packinghouses, we would expect fresh shipments to increase, the fresh PHD price to decline, and perhaps pack-out rates to decline, to the extent that additional fruit sent to packinghouses is of lower quality. More fresh shipments would mean less processed fruit, placing upward pressure on PHD prices for processed fruit. Eventually, such changes would lead to equilibrium condition $ot_1 = ot_2$. In some instances, however, there may be limited or no flexibility in allocating fruit between fresh and processed channels, due perhaps to fruit quality and/or market demand, and this equilibrium may not occur (instead, a corner solution may result; see, for example, Takayama and Judge, 1971). If fruit is grown for processing with little or no care for external appearance, the pack-out rate *w* will tend toward zero, and no fruit may be sent to packinghouses under any viable fresh and proc-

essing PHD prices in equations (6) and (7). Perhaps, more importantly, the degree of maturation of fruit over a season may limit the utilization of fruit. In the early part of the season, October through December, the quality of juice tends to be relatively low as measured by ratio (% solids/% acid), resulting in low processed prices for grapefruit. During this part of the season, most of the processed fruit comes from eliminations. Field-run grapefruit may simply not be a viable option. Low quality also limits fresh shipments, resulting in relatively high fresh returns during this part of the season. In addition, the optimality maximization condition may not hold when exact prices are unknown at the time of the utilization decision. For example, some growers market via participation plans where processed PHD and on-tree prices are determined after the processor sells the products made from the growers' fruit.

Application

USDA data were used to examine Florida grower returns for grapefruit. PHD price data reported in *Citrus Fruits, 1998 Summary,* and earlier issues, by the National Agricultural Statistics Service are shown in Table 2. PHD prices are given for fresh versus processed utilization for three varieties of grapefruit—white seedless, red-seedless,[3] and seedy. All seedy grapefruit is used in processing; thus, the fresh-processed allocation analysis focuses on the white and red seedless varieties. In Table 3, on-tree price data—reported by the Florida Agricultural Statistics Service[4] in *Citrus Summary, 1997–98* and earlier issues—are shown. The difference between the figures shown in Tables 2 and 3 can be found in Table 4. Based on equation (1), the difference for fresh utilization is fresh pick-and-haul costs (c_1). For processed utilization, the difference is a weighted average of fresh and processed pick-and-haul costs, and elimination costs, as given by equation (3).

Based on Muraro et al. (1998a, 1998b), the difference between fresh and processed pick-and-haul costs is about $.13 per box, and the elimination charge is $1 per box. Estimating c_2 by c_1 minus $.13/box, and c_3 by $1.00/box, equation (4) is used to find the shares of processed fruit that are field-run (Table 5). These shares are then applied to equation (5) to estimate average pack-out rates (Table 5); fresh and processed grapefruit utilization levels underlying the estimated pack-out rates are shown in Table 6.

During the period from 1993–94 through 1997–98, the estimated average pack-out rates for white seedless grapefruit ranged from 38 percent to 48 percent while those for red seedless grapefruit ranged from 58 percent to 77 percent. The low pack-out rates in 1997–98 may reflect below-average growing conditions (high rainfall associated with El Niño, which adversely affected quality) and/or perhaps reduction in grove care due to low on-tree prices. Pack-out rates vary for fruit destined for domestic versus export markets. Exports markets tend to demand higher-quality fruit, resulting in lower pack-out rates.

Table 2. Florida Grapefruit Packinghouse-Door (PHD) Prices, for Fresh Versus Processed Utilization.

Season	Processed		Fresh	
	White Seedless	Red Seedless	White Seedless	Red Seedless
	$/box			
1993–94	3.84	3.43	9.40	6.55
1994–95	3.44	2.42	8.52	4.85
1995–96	3.13	2.33	7.80	4.81
1996–97	2.10	2.74	7.16	5.12
1997–98	1.80	2.62	7.31	4.71

Source: NASS (1998b).

[3]USDA refers to red seedless grapefruit varieties as colored seedless grapefruit. We have adopted the term "red seedless," which is widely used in the industry.

[4] Note that some processed on-tree prices are negative. Negative prices can occur when the elimination shares, (1-v) in equation (3b), are large.

Table 3. Florida Grapefruit On-Tree Prices, for Fresh Versus Processed Utilization.

Season	Processed		Fresh	
	White Seedless	Red Seedless	White Seedless	Red Seedless
	$/box			
1993–94	1.69	1.13	7.55	4.70
1994–95	1.39	-.23	6.75	3.05
1995–96	.88	-.06	5.88	2.96
1996–97	-.18	.20	5.23	3.26
1997–98	-.65	-.05	5.38	2.85

Source: FASS (1998a).

Table 4. Florida Grapefruit Packinghouse-Door (PHD) Minus On-Tree Prices, for Fresh Versus Processed Utilization.[a]

Season	Processed		Fresh	
	White Seedless	Red Seedless	White Seedless	Red Seedless
	$/box			
1993–94	2.15	2.30	1.85	1.85
1994–95	2.05	2.65	1.77	1.80
1995–96	2.25	2.39	1.92	1.85
1996–97	2.28	2.54	1.93	1.86
1997–98	2.45	2.67	1.93	1.86

[a] The difference between PHD and on-tree prices is equal to pick-and-haul costs in the case of fresh utilization, and the weighted average of pick-and-haul costs and elimination costs in the case of processed utilization.

Source: NASS (1998a, 1998b) and FASS (1998a).

Table 5. Estimated Processed Field-Run Rates (v) and Fresh Pack-Out Rates (w) for Florida Grapefruit.

Season	Field-Run Rate		Pack-Out Rate	
	White Seedless	Red Seedless	White Seedless	Red Seedless
	(field-run/processed boxes)		(fresh/fresh+elimination boxes)	
	(v^a)	(v^a)	(w^b)	(w^b)
	%			
1993–94	61.95	48.67	48	77
1994–95	63.72	13.27	44	61
1995–96	59.29	40.71	45	72
1996–97	57.52	28.32	43	64
1997–98	41.48	16.81	38	58

[a] v =field-run boxes/(field-run+elimination boxes):
c1=fresh pick-and-haul cost per box.
c2=c1-$.13/box=processed pick-and-haul cost per box, where $.13/box is for drenching.
d=PHD price minus on-tree price.
Elimination cost=$1.00/box.
Hence: d=v(c1-.13)+(1-v)(c1+1),
or v= -(d-c1-1)/1.13.

[b] w is based on application of v to fresh and processed grapefruit utilization shown in Table 6.

Table 6. Fresh and Processed Utilization for Florida Fresh Grapefruit.

Season	White Seedless			Colored Seedless		
	Fresh	Processed	Total	Fresh	Processed	Total
	1,000 boxes					
1993–94	6,459	18,041	24,500	16,043	9,457	25,500
1994–95	5,720	19,980	25,700	16,519	12,181	28,700
1995–96	5,862	17,338	23,200	16,981	11,119	28,100
1996–97	5,664	17,836	23,500	17,573	13,827	31,400
1997–98	4,791	13,509	18,300	16,369	14,231	30,600

Source: FASS (1998a).

Roughly 80 percent and 40 percent of fresh white and red seedless grapefruit shipments, respectively, are exported, underlying the lower pack-out rates for white seedless grapefruit. Also, fresh prices for exports tend to be higher than domestic prices, and the premium for white seedless exports tends to be higher than that for red seedless exports. These differences are also reflected in the higher fresh PHD and on-tree prices for white versus red seedless grapefruit in Tables 2 and 3.

In Table 7, estimates of on-tree prices for fruit sent to packinghouses (a weighted average for fresh and eliminated fruit) versus field-run fruit sent to processing plants—based on equations (6) and (7)—are shown. The results show that the weighted average on-tree price for fresh and eliminated fruit is much greater than the on-tree price for processed field-run fruit. These results suggest that, on average, an inadequate volume of fruit was allocated to the fresh channel. Below, we discuss the possibility that other constraints limit the flow of fruit into the fresh market channel.

With constant fresh and processed PHD prices, the fresh-processed allocation would be in equilibrium ($ot_1 = ot_2$ in equations (6) and (7)) when the equilibrium pack-out rates shown in Table 7 are reached. During the past five seasons, estimated equilibrium pack-out rates ranged from 16 percent to 20 percent for white seedless grapefruit and from 25 percent to 33 percent for red seedless grapefruit. With one exception, actual pack-out rates are more than two times the estimated equilibrium rates.

Why are actual and equilibrium pack-out rates so different? The corner solutions for allocation problem (8) provide one explanation. During the early part of the season, fresh and processed utilization opportunities may be limited as a result of low-quality fruit and juice, as was previously discussed.[5] At other times of the season, pack-out rates may drop off sharply for some marginal fruit. Also, for tractability, the analysis in Table 7 is based on the assumption that the season average processed PHD prices for field-run and eliminated grapefruit are the same. This assumption, however, may not always hold. During parts of the season, processed PHD prices could be slightly greater than zero, and eliminated fruit (but not field-run fruit) could still be processed to partially offset pick-and-haul costs and elimination charges, which are essentially fixed costs at the point of elimination. (Whatever small PHD price is received helps to minimize the losses.) In this case, processed on-tree prices for eliminations could be quite negative, approaching $-c_1-c_3$. At other times in the season, field-run fruit could be processed at PHD prices that are slightly greater than or about equal to field-run pick-and-haul costs, resulting in field-run processed on-tree prices that are near zero, the lowest level that such prices would be

[5] On-tree prices, ot_1 and ot_2, may not be equal with the industry at a corner solution with respect to maximization of consumer surplus. Juice quality may be low, resulting in low processed prices, and this, in turn, may result in little, if any, field-run fruit. At the same time, the volume of fruit that meets fresh standards may be small, resulting in relatively high fresh prices. The only processed fruit may be low-quality eliminated fruit.

Table 7. Estimated Florida Grapefruit On-Tree Prices Derived for Fresh Versus Processed Channels.

Season	Fresh On-Tree	Processed PHD	Fresh Pick-and-Haul	Elimination Cost	Elimination On-Tree[a]	Pack-Out Rate	Wt. Avg. Fresh- Elimination[b]	Field-Run On-Tree[c]	Equilibrium Pack-Out Rate[d]
	----------$/box----------					--%--	----------$/box--------		--%--
White Seedless									
1993–94	7.55	3.84	1.85	1.00	.99	48.48	4.17	2.12	17.23
1994–95	6.75	3.44	1.77	1.00	.67	44.10	3.35	1.80	18.59
1995–96	5.88	3.13	1.92	1.00	.21	45.37	2.78	1.34	19.93
1996–97	5.23	2.10	1.93	1.00	-.83	42.78	1.76	.30	18.65
1997–98	5.38	1.80	1.93	1.00	-1.13	38.14	1.35	0	17.36
Red Seedless									
1993–94	4.70	3.43	1.85	1.00	.58	76.77	3.74	1.71	27.43
1994–95	3.05	2.42	1.80	1.00	-.38	60.99	1.71	.75	32.94
1995–96	2.96	2.33	1.85	1.00	-.52	72.03	1.99	.61	32.47
1996–97	3.26	2.74	1.86	1.00	-.12	63.94	2.04	1.01	33.43
1997–98	2.85	2.62	1.86	1.00	-.24	58.03	1.55	.89	36.57

[a] Processed PHD - fresh pick-and-haul - elimination cost.
[b] Fresh on-tree price weighted by the pack-out rate plus the elimination on-tree price weighted by one minus the pack-out rate.
[c] Processed PHD - (fresh pick-and-haul - $.13/box for drenching).
[d] (field-run on-tree - elimination on-tree)/(fresh on-tree-elimination on-tree).

expected to go. Under such conditions, the USDA weighted average processed on-tree price (2a) would be expected to be negative, as has occurred recently (Table 3). In addition, it should be noted that fresh and processed PHD prices and, in turn, on-tree prices, ot_1 and ot_2, may be sensitive to fresh and processed utilization levels, depending on the magnitude of the demand elasticities for fresh and processed grapefruit.[6] Nevertheless, the large differences in actual and equilibrium pack-out rates suggest that fresh-processed opportunities to improve grower returns may exist in the long run.

One possibility of taking advantage of better grower on-tree prices for fruit sent to packinghouses is to decrease the maturation time period needed to obtain high-quality fruit. Industry research related to increasing the maturation process is being conducted; such an increase would allow growers to ship more early-season fresh grapefruit and to take advantage of discrepancies between ot_1 and ot_2. Grove care and associated costs needed to speed the maturation process have not been determined. General estimates of the cost of growing grapefruit have been made (Muraro et al., 1998a, 1998b), however, which may be useful for grove care planning.

In general, fresh grapefruit allocation opportunities depend on the difference in ot_1 and ot_2, versus the additional grower costs required for fresh fruit. Additional costs would be justified when they are less than ot_1 - ot_2. Estimates of production costs for growing fresh versus field-run processed grapefruit are shown in Table 8 (Muraro et al., 1998a, 1998b). On average, the difference in the cost of growing fresh and field-run processed grapefruit is about $.66 per box, which is less than the difference in on-tree price for fresh market utilization and the on-tree price for field-run fruit, for each of the last five seasons for both white and red seedless grapefruit, as shown in Table 7. Hence, for example, assuming the mid-range (1995–96) estimates for ot_1 and ot_2 for red seedless grapefruit, reallocation of 100 boxes of grapefruit from processed to fresh channels by a price taker would result in an estimated increase in fresh channel on-tree revenue of $199 ($2.96/box times 72 boxes of fresh shipments minus $.52/box times 28 boxes of eliminations) and a decrease in processed channel on-tree revenue of $61, or a net increase of $138 in revenue, compared to the additional cost of $66 for growing fresh market fruit. The pack-out rate, the cost of producing grapefruit, and market prices can vary significantly from the averages used in this example; that is, at certain points of the season, the opportunity to increase returns may differ substantially from those indicated in this example.

It should also be noted that, for grove care planning, estimates of future PHD prices for fresh and processed fruit are required. Fresh market prices have been somewhat flat, although higher in the 1998–99 season due, in part, to the freeze in California. Processed fruit prices have also recently improved with the expansion of retail sales in grocery stores. Future fresh and processed prices will depend on elasticities of fresh and processed demands with respect to prices, elasticities of pack-out rates with respect to fresh utilization, and fresh and processed demand growth rates in U.S. and export markets, along with future supply.

Concluding Comments

Market forces can be expected to result in supply changes in the Florida grapefruit industry. Large supplies and low grower returns have resulted in reductions in grapefruit trees and acres, but further reductions appear necessary to allow the Florida grapefruit industry to return to profitability. During the adjustment process, opportunities may exist to increase profitability through a more profitable allocation of fruit between fresh and processed channels. Based on recent historical data, fresh channel returns have been much greater than processed returns, suggesting opportunities to send additional fruit to packinghouses. Presently, fruit quality may limit fresh-processed utilization options, but research on increasing the maturation process may expand those opportunities.

[6] The elasticity of U.S. demand for fresh grapefruit has been estimated at -.5 at the retail level (Thompson, Conklin, and Dono, 1990) while the elasticity of U.S. demand for grapefruit juice has been estimated at -1.3 to -1.5, also at the retail level (Brown and Lee, 1993); however, at the grower level, demand elasticities could be quite different.

Table 8. Florida Grapefruit Grower Costs, 1997–98 Season.

Item	Indian River Grapefruit Fresh	Field-Run Indian River Grapefruit Processed	Southwest Grapefruit[1] Fresh	Field-Run Southwest Grapefruit[1] Processed	State Average[2] Grapefruit Fresh	Field-Run State Average[2] Grapefruit Processed
Regional and State Average Costs						
				$/acre		
Production/Cultural	926.17	664.47	819.44	642.67	892.37	657.57
Other[3]	389.85	389.85	367.85	367.85	382.88	382.88
Total	1,540.13	1,240.34	1,350.06	1,139.45	1,479.94	1,208.39
State Average Summary and Cost-per-box Estimates						
	--/acre--	-boxes/acre-[4]	-$/box-			
Total Fresh Cost	1,479.94	411	3.60			
Total Processed Field-Run Cost	1,208.39	411	2.94			
Additional Fresh Cost	271.55	411	.66			

[1] Costs for Southwest region of Florida are assumed to apply to other areas of Florida, excluding the Indian River region.

[2] Weights for calculating state average based on the FASS (1998b).

Region	Florida Grapefruit Acreage	
	Acres in 1998	% State Total
Indian River	90,760	68
Other	42,057	32
State	132,817	100

[3] Includes interest on operating costs, management costs, taxes and regulatory fees, and interest on average capital investment.

[4] Average from 1993–94 through 1997–98 (FASS, 1998a).

SOURCE: Muraro et al. (1998a, 1998b).

The results of this study also show that data reported by the USDA, although useful for examining overall or aggregate fresh and processed returns, do not directly indicate grower returns through fresh versus processed channels. The latter information is critical for the fresh versus processed allocation planning. With knowledge of a few parameters, pack-out rates, which will allow better analysis of the allocation decision, can be estimated.

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