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FACTORS REDUCING FRESH GRAPEFRUIT PACKOUTS IN FLORIDA: CAN PACKOUTS BE IMPROVED?

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Abstract. **The greatest financial returns for grapefruit are achieved by selling fruit for the fresh market. While Florida growing conditions yield fruit of exceptional internal quality, they also favor the development of cosmetic defects that often render the fruit marketable only for juice. Such defects include under/over-sized fruit, windscar (and other mechanical peel injuries), poor fruit color, misshapen fruit, fungal blemishes (e.g., melanose), arthropod damage (e.g., rust mite), sunburn, and freezing injury. Some of these defects are major elimination factors each year, but the incidence and relative importance of most varies from year to year. Average grapefruit packouts have declined by almost 1/3 for both white and colored varieties over the past two decades, suggesting that market demands and/or cultural practices may have shifted. Defects due to windscar, melanose, poor shape, and off-size were identified as top causes of fruit elimination, indicating that practices to reduce these fruit blemishes might have a substantial impact on improving packouts and returns to Florida growers and packers. Packouts of red varieties continue to be significantly higher than those for white grapefruit, but our limited data do not support the idea that tree age (white grapefruit trees in Florida tend to be older) is the primary reason. Packouts tend to decrease as the season progresses. Therefore, lower packouts can be expected when packing for markets that order grapefruit later in season. Awareness of this trend might enable some growers to target earlier sales for better returns, but it is unlikely to affect packouts across the entire industry. When surveyed, packinghouse managers cited market demands for more perfect fruit and shifts in sales to more demanding markets (such as Japan) as the most likely causes of declining packouts.**

The Importance of Higher Packouts

Compared with fruit sold for juice, grapefruit sold for the fresh market bring much higher returns to growers and packers. For example, during the five seasons between fall 1997 and spring 2002, the average on-tree price growers received for fresh white seedless grapefruit was $7.01 per 1.6 bu box (56.4 L), compared to $0.75 for the same fruit if processed (Fla. Agr. Statistics Service, 2003). During the same period, fresh colored seedless grapefruit returned $4.42 per box, whereas processed fruit returned only $0.32 per box. While packers usually charge a handling fee for fruit eliminated from the fresh market due to blemishes, shape, color, etc. ("eliminations"), they make most of their revenue from the fruit actually shipped fresh. Thus, net returns to both the grower and packer are strongly related to the percentage of grapefruit shipped fresh (=packout) (Grierson, 1957). If very low packout is predicted for a load of fruit, such that elimination handling costs would be greater than the fresh fruit net returns, the entire load is often sent directly to the processor (or left unharvested if prices for processed fruit do not cover the harvesting and hauling charges).

Declining Grapefruit Packouts in Florida

While Florida growing conditions yield fruit of exceptional internal quality, they also favor the development of cosmetic defects that often render the fruit marketable only for juice. Such defects include under/over-sized fruit, windscar (and other mechanical peel injuries), poor fruit color, misshapen fruit, fungal blemishes (e.g., melanose), arthropod damage (e.g., rust mite), sunburn, and freezing injury. Numerous reports describe a plethora of different citrus fruit blemishes and research intended to understand and reduce their occurrence (Albrigo, 1978). However, rather than steadily improving packouts with improved practices and new information, data from the Fla. Agr. Statistics Service (2003) show that average grapefruit packouts have declined over the past two decades (Figs. 1 and 2). While year to year fluctuations are common, total utilization (fresh and processed) of white grapefruit tended to decline from over 25 million boxes in the 1981-82 season to

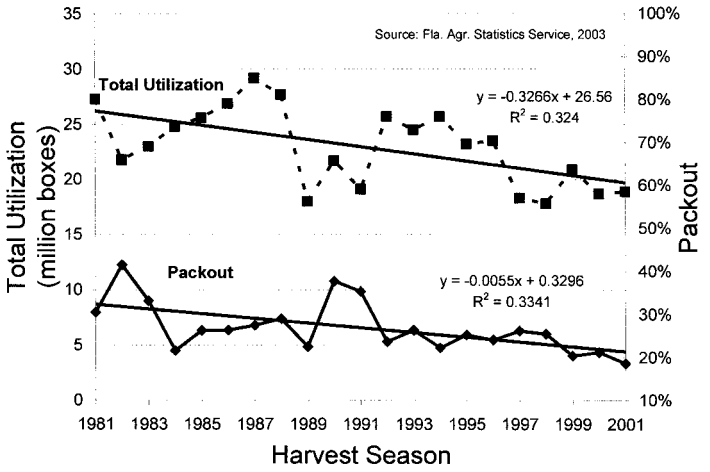

Fig. 1. Total utilization (fresh and processed) and annual average fresh packout for Florida white seedless grapefruit between the 1981-82 and 2001-02 seasons. Straight lines represent the best fit linear regression trends each for utilization and packout. Source: Florida Agricultural Statistics Service, Citrus Summary, 2000-01.

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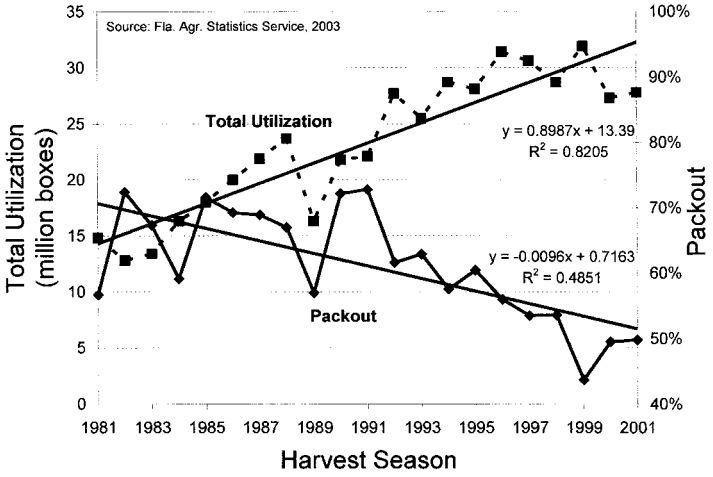

Fig. 2. Total utilization (fresh and processed) and annual average fresh packout for Florida colored seedless grapefruit between the 1981-82 and 2001-02 seasons. Straight lines represent the best fit linear regression trends each for utilization and packout. Source: Florida Agricultural Statistics Service, Citrus Summary, 2000-01.

less than 20 million boxes in 2001-02, and average fresh packouts for white seedless grapefruit declined from 31% in 1981-82, to 19% in 2001-02 (Fig. 1). Total utilization of colored grapefruit increased substantially from 15 million boxes in 1981-82, to 28 million boxes in 2001-02 (Fig. 2). While packouts of colored seedless grapefruit are much higher than for white seedless, they dropped sharply from a high of 73% during the 1991-92 season, to 50% during the 2000-01 and 2001-02 seasons. It is believed by some packers that the red blush (peel pigmentation) on many colored grapefruit cultivars hides peel blemishes and may be one reason for higher packouts. The declining packouts of white and colored grapefruit suggest that market demands, changing markets, and/or cultural practices may have shifted. The purpose of this paper is to explore factors which may contribute to this decline in packouts in an effort to identify opportunities for better returns.

Fruit Blemishes

Previous studies have identified the primary causes of grapefruit eliminations from the fresh market (Grierson, 1958; Grierson and Oberbacher, 1957; Miller and Burns, 1992) and their data is summarized in Table 1. In these reports, the authors visited different packinghouses, took samples of fruit eliminations, and identified the primary cause of elimination for each fruit. The reader should realize that an average of 16% windscar indicates that windscar was the primary defect on 16% of the unmarketable fruit, and not that 16% of all harvested fruit were unmarketable because of windscar. Table 1 reveals that some blemishes, such as windscar and melanose, consistently caused a relatively large percentage of the eliminations. However, the occurrence of several blemishes varied widely from year to year. For example, in 1956-57, a high percentage of fruit with poor color development (46%) was noted with the author describing the season as one "in which almost universal difficulty was experienced with degreening" (Grierson, 1958). In addition, 1991-92 was marked by an unusually high percentage of elimination due to off-sizes and poor shape. Industry reports indicate that poor shape (sheepnosing) was also high this past season (2002-03). Miller and Burns (1992) also reported large variability in the occurrence of blossom-end clearing and greasy spot between seasons.

Table 1. Causes of grapefruit eliminations from the fresh market for the 1956-1959 and 1990-1992 seasons. Numbers are percent of eliminations, and not percent of total production. Highest factors in each year are underlined.

	Percent of eliminations				
Defects	1956-57[z]	1957-58[z]	1958-59[y]	1990-91[x]	1991-92[x]
Color	<u>46</u>	12	10	na	na
Windscar	16	<u>27</u>	<u>33</u>	<u>34</u>	<u>27</u>
Rust mite	19	3	9	na	na
Melanose	9	<u>36</u>	<u>24</u>	9	14
Scale	2	1	7	na	na
Plugged	na	2	3	na	na
Off-size	4	5	1	4	<u>15</u>
Mechanical injury	1	4	1	8	9
Shape	2	3	4	4	<u>20</u>

[z]Source: Grierson, 1958.
[y]Source: Grierson and Oberbacher, 1959.
[x]Source: Miller and Burns, 1992.

To provide more recent data on trends in grapefruit defects common in Florida, a survey of Florida citrus packinghouse managers was conducted in May and June of 2003. Managers were asked to estimate the number of years that different fruit defects represented the primary cause of elimination during the past 7 years, and the number of years that each defect was among the top five causes of elimination. Responding packinghouse managers represented 8.7 million cartons (4/5 bu) of grapefruit shipped during the 2001-02 season (Fla. Dept. of Agr. and Consumer Services, 2002), or about 27% of all fresh grapefruit shipped that season. Responses from the survey agreed very closely with most previous reports. The top cause of grapefruit elimination was windscar, which respondents indicated was the primary cause of elimination in an average of 3.6 of the past 7 years, and was among the top five causes of elimination every year for the past 7 years (Table 2). Eliminations due to melanose, poor

Table 2. Summary of 2003 survey of Florida citrus packinghouse managers indicating average number of seasons respondents believed each type of defect was the primary cause of grapefruit elimination, or among the top 5 causes of grapefruit elimination from the fresh market for the past seven seasons. Numbers in parenthesis represent standard deviation.

	Average response (yrs. out of the past 7 yrs.)	
Cause of elimination	#1 Cause	Top 5
Windscar	**3.6** (2.8)	**7.0** (0.0)
Melanose	**0.9** (1.2)	**6.5** (1.6)
Poor shape	**1.3** (1.3)	**5.5** (2.2)
Off-size	**1.0** (1.5)	**4.1** (2.2)
Plug/puncture	0.0 (0.0)	3.2 (2.6)
Greasy spot (pink pitting)	0.6 (1.0)	2.9 (2.8)
Insect injury	0.3 (0.7)	2.2 (2.4)
Green Color	0.1 (0.3)	2.1 (1.8)
Oleocellosis	0.3 (0.9)	1.4 (1.6)
Other	0.2 (0.6)	0.7 (1.2)
Chemical burn	0.1 (0.3)	0.7 (1.3)
Soft/spongy	0.0 (0.0)	0.6 (1.0)
Decay	0.2 (0.6)	0.4 (1.3)
Hail damage	0.1 (0.3)	0.1 (0.3)

shape, and off-size were also listed as among the top five causes of elimination 6.5, 5.5, and 4.1 years, respectively, of the past 7 years. Based on these results, research that could reduce these fruit blemishes and better manage fruit size and shape would have the greatest impact on improving packouts and returns to Florida growers and packers.

Survey participants were also asked for what they believed was the primary causes of declining packouts. Respondents cited increased market demands for blemish-free fruit and shifts in sales to more demanding markets as the most likely causes (data not shown). However, respondents also believe that a reduction in resources invested into grove care and the age of existing groves may also play a role.

Markets

Florida grapefruit are marketed and shipped to both domestic and foreign markets. Shipments to domestic markets steadily declined since 1989-90 (Fig. 3; Fla. Dept. of Citrus. 2003a). However, export markets (especially Japan and Europe) increased over the same time period (Fig. 3) and volume exported accounted for about 65% of all fresh Florida grapefruit in 2001-02. The top grapefruit-shipping counties (Indian River and St. Lucie) exported 75% of their fresh grapefruit in 2001-02 (Fla. Dept. of Agr. and Consumer Services, 2002). In the same season, shipments to Japan topped all other markets, including domestic (Fig. 3).

While Marketing Order No. 905 requires all fruit exported or shipped interstate or west of the Suwannee River to meet U.S. grade standards of U.S. #1 or better, the ultimate quality standard is set by the buyer. For example, individual Japanese buyers have their own minimum quality requirements and hire their own fruit inspectors to visit packinghouses and assure that those standards are met. Packers and shippers generally regard Japanese markets as having the most stringent external quality requirements, European markets are regarded as somewhat less stringent, and domestic markets as the least stringent.

Few growers maintain data on packout from individual blocks over consecutive seasons; however, we were fortunate to acquire a substantial data set from one integrated grove and packinghouse operation, providing greater consistency of handling than might occur if fruit were marketed through several packinghouses. Table 3 shows percent packout data for fruit harvested December to February during the 1997-98 to 2002-03 seasons from different grapefruit varieties within this contiguous Indian River citrus grove. All white 'Marsh' grapefruit were shipped to Japan, and 80%-90% of the 'Flame' grapefruit were shipped to Europe with the rest sold to domestic markets. Half of the total packed 'Red Marsh' grapefruit were exported to Europe and half shipped domestically. As is typical across Florida, colored grapefruit consistently had higher packouts compared to white 'Marsh' grapefruit (Table 3). Tree age did not appear to be a major factor because the red and white 'Marsh' grapefruit were both planted in 1967 or 1968, but the 'Red Marsh' consistently resulted in much higher packouts, even though the blocks received identical care and had similar fruit size distributions (data not shown). Further discrediting the idea that tree age affects packouts, the two young 'Flame' blocks showed no obvious trend of declining packout as they grew older. It should be noted that many growers have commented on better packouts from young trees, since they tend to display fewer fungal blemishes and often better fruit size (personal communication).

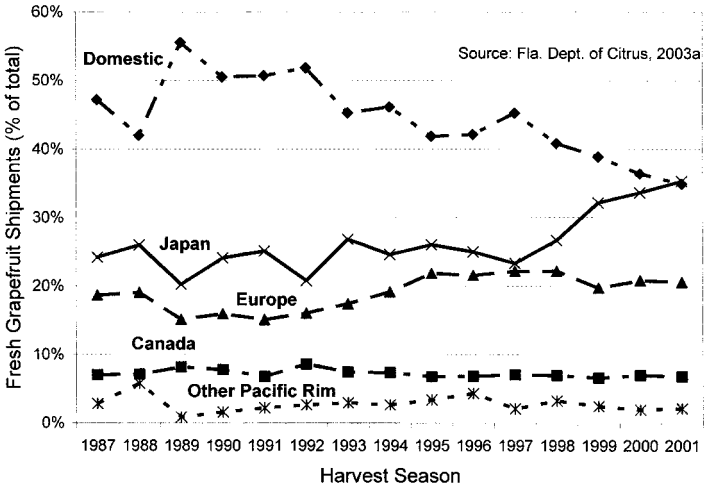

Fig. 3. Distribution of Florida fresh grapefruit shipments to different markets between the 1987-88 and 2001-02 seasons (Fla. Dept. of Citrus, 2003a).

The fact that the white 'Marsh' grapefruit were shipped to the more selective Japanese market compared to the domestic/European-marketed 'Red Marsh' likely had the largest impact on packouts. 'Flame' grapefruit had the highest packouts except during the 2001-02 season when the fruit were shipped to Japan instead of Europe and had only 32% packout. While the approximate 30% decline in packout compared to the preceding and subsequent years may be a coincidence, it likely reflects the more stringent external quality requirements of the Japanese market.

Taken together, shifting Florida grapefruit sales to focus on markets with more stringent quality standards appears likely to be the biggest factor reducing overall packouts. Japan, for example, has traditionally purchased virtually all (92% in 2001-02) of Florida's white grapefruit. While Japanese markets bring relatively high prices for the fruit, very few markets exist for the fresh white grapefruit not marketable in Japan (e.g., of sizes not wanted by the Japanese). Sales of colored grapefruit to Japan have increased markedly in recent years from 21% of the total production (2.3 million cartons) in 1995-96, to 55% of the total (6.1 million cartons) in 2001-02 (Fla. Dept. of Agr. and Consumer Services, 1996, 2002). The increased percentage of colored grapefruit shipped to Japan may be one of the causes for noticeably lower packouts since 1991. If the harvest quality of grapefruit remains constant, packouts of colored grapefruit can be expected to decrease as the percentage shipped to Japan and Europe increases relative to domestic or less stringent markets.

Change in Packouts Over the Season

The time of year when Florida grapefruit are harvested may also affect the final packout. Packout data over three seasons from nearby blocks of 'Flame' and 'Red Marsh' grapefruit in the Indian River region show that packouts tend to decline over each season from highs of about 90% in October, to lows of about 30% in April and May (Figs. 4 and 5). Short term changes within each season likely resulted from variability within the blocks being harvested, blemishes resulting from adverse weather conditions (e.g., rain causing oleocellosis), and harvesting practices (e.g., plugging). Declining

Table 3. Percent fresh packout of fruit harvested from a contiguous Indian River citrus grove in December-February 1997-2003. All white 'Marsh' were shipped to Japan and, most (80%-90%) of the 'Flame' were shipped to Europe (remainder sold domestic). Half of the total packed 'Red Marsh' were exported to Europe and half shipped domestically. A notable exception to the above is that fruit from the block of 'Flame' with 32% packout in 2001-02 were shipped to Japan.

		Packout (%)						
Grapefruit cultivar	Year planted	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	Mean
'Flame'	1991	63	71	79	87	55	63	70
'Flame'	1989	47	74	65	76	**32**	60	59
Red 'Marsh'	1967	51	65	53	60	54	49	55
Red 'Marsh'	1968	41	68	54	76	58	48	58
White 'Marsh'	1967	35	32	34	59	—	—	40
White 'Marsh'	1967	20	37	43	32	—	—	33
Mean of reds		51	70	63	75	50	55	

packouts during the season were also observed for a block of white 'Marsh' grapefruit shipped to Japan where packouts declined from 59% in October-November, to 28% by February-March (data not shown). Packers report that as the season progresses, fruit become softer, more misshapen, and generally develop more external blemishes. Therefore, all other factors being equal, grapefruit packouts would be expected to be highest on fruit harvested and shipped early in the season (October-November).

Accumulation of external blemishes may be only partly responsible for declining packouts as the season progresses. Domestic markets concentrate purchases in November and December for Thanksgiving through Christmas sales. European markets typically order fruit throughout the season, but tend to increase their orders after January when degreening is rare and internal quality is higher. Japanese markets purchase relatively little Florida fruit before January, with most shipments to Japan occurring later in the season (February-March) when internal quality is often highest. Based on the blemish tolerance of these three markets, it is apparent that the proportion of fruit subject to more stringent appearance standards is likely to increase as the season progresses. However, this cannot be the primary factor influencing seasonal shifts in packout since trends are very similar even when fruit are almost exclusively reserved for a single market sector.

Since most Florida grapefruit blocks are spot-picked several times for fresh sales, it may be that the most attractive fruit are removed with each picking, thus increasing the proportion of blemished fruit in subsequent harvests. Discussions with Indian River growers and packers (pers. comm.) suggest that this is unlikely since size is the primary consideration in spot picking and many blemishes are obscured by sooty mold when fruit are on the tree.

Conclusions

It is apparent that many factors influence the packout of white and colored grapefruit. Eliminations result from factors like fruit windscar, melanose, poor shape, or off-sizes and therefore improvement of practices that reduce their occurrence could significantly increase packout and economic returns to growers and packers. Colored grapefruit tend to have much higher packout than white grapefruit, but even choice of cultivar may offer the grower little control over future earnings. Analyses of on-tree values of white and colored grapefruit for fresh and processed sales (Fla. Dept. of Citrus, 2003b) indicate that from 1999-2002 the per acre values of white grapefruit at 20% packout have been comparable to red grapefruit at 50% (Fig. 6). Packouts decrease as the season progresses, apparently due to continued accumulation of blemishes, and possibly market factors. While awareness of this trend might enable some growers to target earlier sales for better returns, it is unlikely to improve packouts across the entire industry. Many growers report good packouts from young trees, but from our limited data, the effects appear to be short-lived and offer little opportunity for improved man-

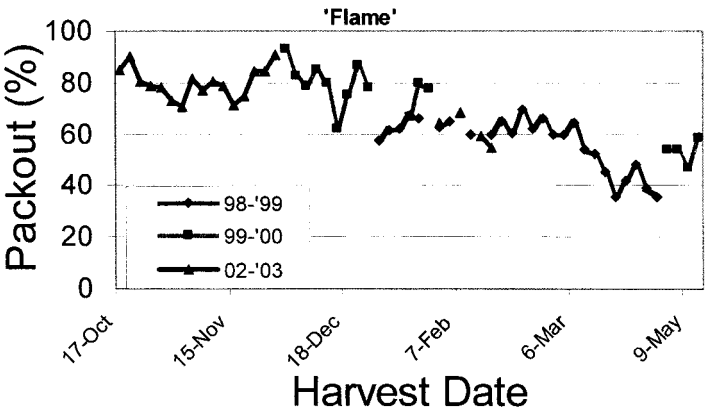

Fig. 4. Seasonal change in fresh packouts of 'Flame' grapefruit from a single Indian River grove over three seasons. Trees were planted in 1991.

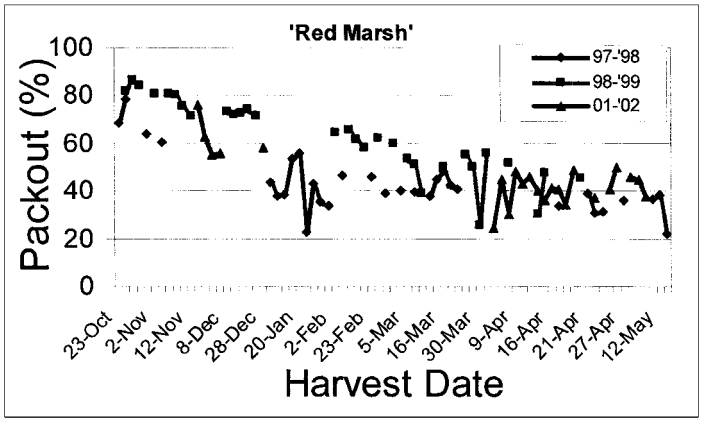

Fig. 5. Seasonal change in fresh packouts of 'Red Marsh' grapefruit from a single Indian River grove over three seasons. Trees were planted in 1968.

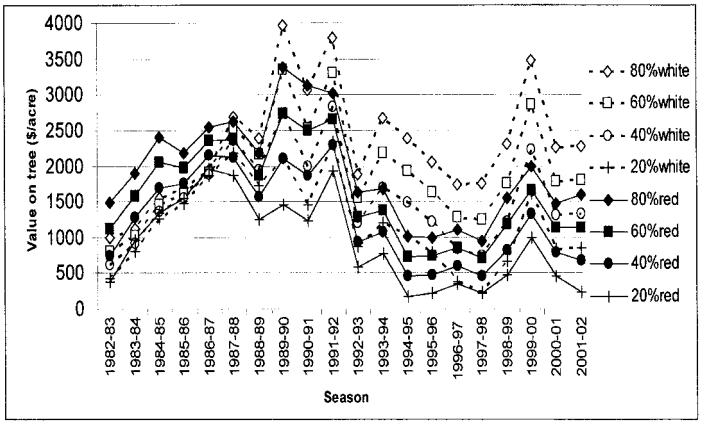

Fig. 6. Effect of packout (indicated as %) on value per acre of grapefruit on tree. Economic values are projected for average production of 420 boxes per acre (Muraro et al., 2003) using on-tree prices for colored and white grapefruit packed fresh and processed (Fla. Dept. of Citrus, 2003b).

agement. Overall, our analyses suggest that the ability of customers to demand fruit with excellent external appearance is the primary factor driving a reduction in grapefruit packouts. The market forces that permit more stringent selection are willingness of more selective customers to pay a higher price and availability of fruit vis-à-vis demand. This leads us to the conclusion that is often repeated but difficult to implement: the solution to poor grapefruit prices is to markedly enhance demand relative to production.

While our discussion has focused on appearance, and many customers focus on fruit appearance in making their purchases, internal quality is critical for repeat sales and its importance is apparent in purchase dates from Japanese and European markets each year. Newly enacted increases in minimum Brix requirements for fresh Florida grapefruit sales are an important step toward improving internal quality of early season fruit. Florida grapefruit at its peak is renowned for its high internal quality. Although some customers currently order "off-grade" fruit (with more blemishes but with guaranteed internal quality), shipment volumes are still minor. Continued customer education and marketing which emphasizes internal quality and de-emphasize external appearance may provide the greatest opportunities to increase packouts in the long-run. An extreme example is the availability of equipment to commercially produce peeled and sectioned grapefruit that completely eliminates the peel as a quality factor and may be an important step in focusing consumer attention on internal quality.

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