Economic Analysis of Incentives to Plant Citrus Trees in Florida

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Summary. New citrus (*Citrus* sp.) tree plantings in Florida have been less than 50% of tree mortality/removal rates as indicated by the rate of decline in the Florida commercial citrus tree inventory. The significant decline in tree inventory in recent years, largely due to the citrus disease known as huanglongbing [HLB (*Candidatus liberibacter*)], remains a critical factor contributing to the sharp decline in citrus production in Florida. Concerns over significantly higher costs of production and the uncertainty associated with the spread of HLB have prompted industry leaders and governmental agencies to develop strategic incentives to promote reinvestment in planting new citrus trees to producers. Several programs have been proposed to encourage new plantings of early- and midseason oranges [*Citrus sinensis* (primarily 'Hamlin')], 'Valencia' orange, and grapefruit (*Citrus ×paradisi*) in Florida. Several existing citrus tree replanting programs are evaluated using net present value (NPV) methods to analyze the outcome of the investment.

The Florida citrus industry, which has been the leading producer of citrus in the United States for several decades, is facing a crisis. Citrus crops have declined precipitously over the past 12 years due to a combination of factors, most notably those associated with pests and diseases. One particular disease, HLB, also known as citrus greening, is the latest and strongest threat to the industry. Total Florida citrus acreage has declined by nearly 20% since HLB was first discovered in 2005 from 621,373 acres in the 2005–06 season to 501,396 acres at the end of the 2014–15 season [National Agricultural Statistics Service (NASS), 2015]. The rate of fruit drop has more than doubled over the last decade for all cultivars of citrus. Per tree fruit yields are at an all-time low. Abandoned citrus acreage, estimated at more than 130,000 acres in 2015, serves as a safe haven for the asian citrus psyllid (*Diaphorina citri*), the vector known to spread HLB. Citrus production in Florida has drastically declined over a few short seasons and is at its lowest point in more than 50 years. The U.S. Department of Agriculture (USDA) estimate for the 2015–16 orange crop is 81.5 million 90-lb boxes, down from the near record of 242 million boxes produced in 2003–04 (NASS, 2016a). It is also down substantially from the post hurricane crop of 170.2 million boxes produced in 2007–08. The NASS estimate for the 2015–16 grapefruit crop is 10.85 million 85-lb boxes, down from 40.9 million boxes produced in the 2003–04 season.

The reduced crop forecast reflects a number of factors, including lower per tree fruit yields and reduced fruit quality. Early- and midseason and 'Valencia' orange yields per tree have declined by 33% and 27%, respectively, between the 2011–12 and 2014–15 seasons (Fig. 1). 'Marsh' white grapefruit and red/pink grapefruit (e.g., 'Redblush') yields have declined by 31% and 26%, respectively, between the 2011–12 and 2014–15 seasons (Fig. 2). Fruit quality, as reflected in the decline in juice yields measured in pounds solids (ps) per box for processed early- and midseason and 'Valencia' oranges, experienced a decline of 11% and 12%, respectively, since the 2011–12 season (Fig. 3).

Another crucial component for long-term viability of the citrus industry is the rate of new tree plantings, which have lagged considerably during a very pivotal time in the industry, even with higher grower prices associated with smaller crops. New plantings have been running at less than 50% of the level needed to sustain the existing tree inventory (Fig. 4). In a recent paper, Spreen et al. (2014) document the decrease in new citrus plantings that is apparently a consequence of reduced yields, higher grove maintenance costs, and increased uncertainty associated with HLB.

The purpose of this paper is to examine the economic viability of new citrus tree plantings across various programs designed to encourage new tree plantings. Each of the programs evaluated, some of which have already been implemented, are described and analyzed under common assumptions regarding new tree costs, grove maintenance costs, and per tree yields.

In this paper, new investment in both processed orange and fresh-market grapefruit production is analyzed. The rate of decline in grapefruit production exceeds the decline in orange production on a percentage basis. There has also been a steep decline in other fresh-market citrus types such as 'Washington' navel orange (*Citrus sinensis*) and both early- and late-season tangerines (*Citrus reticulata*). Although explicit results for the other fresh-market citrus are not shown, the grapefruit analysis could be easily extended to specialty citrus cultivars/types.

The investment model

Investment in citrus trees requires multiyear financial planning to analyze the profitability of the investment in the long run. The standard approach to analyze such an investment is the calculation of the NPV of the investment (Kay and Edwards, 1999); "The net present value method is a preferred method of evaluation, because it does consider the time value of money as well as the size of the stream of cash flows

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.4047	acre(s)	ha	2.4711
0.4536	lb	kg	2.2046

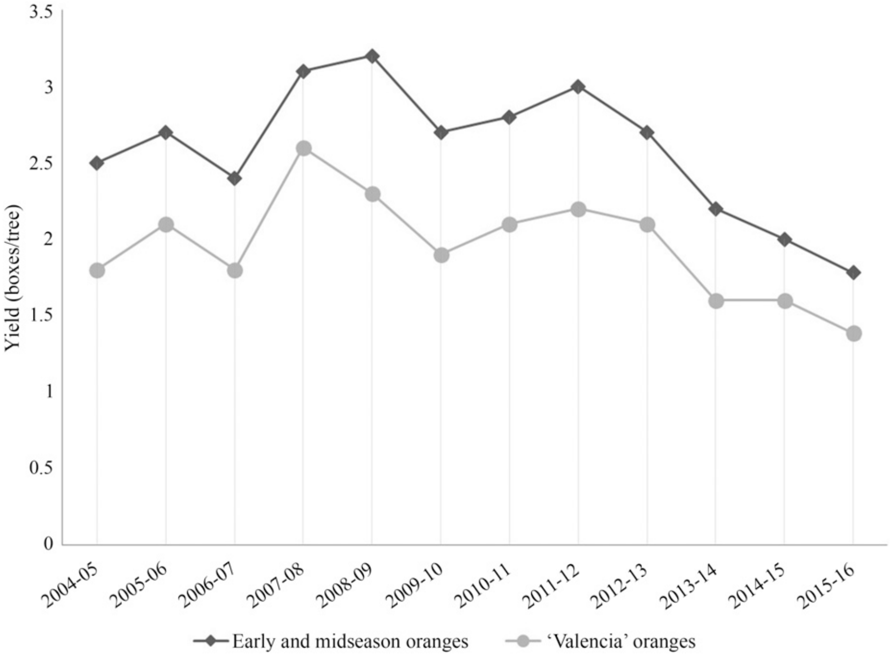

Fig. 1. Huanglongbing has had an adverse impact on orange production yields as reflected by the significant decline in the weighted average early- and midseason orange production yields [90-lb (40.82 kg) boxes/tree] and the weighted average 'Valencia' orange production yields (90-lb boxes/tree), from the 2004–05 season through the 2015–16 (forecasted) season; the severity of the decline has especially been observed since the 2011–12 season (National Agricultural Statistics Service, 2015).

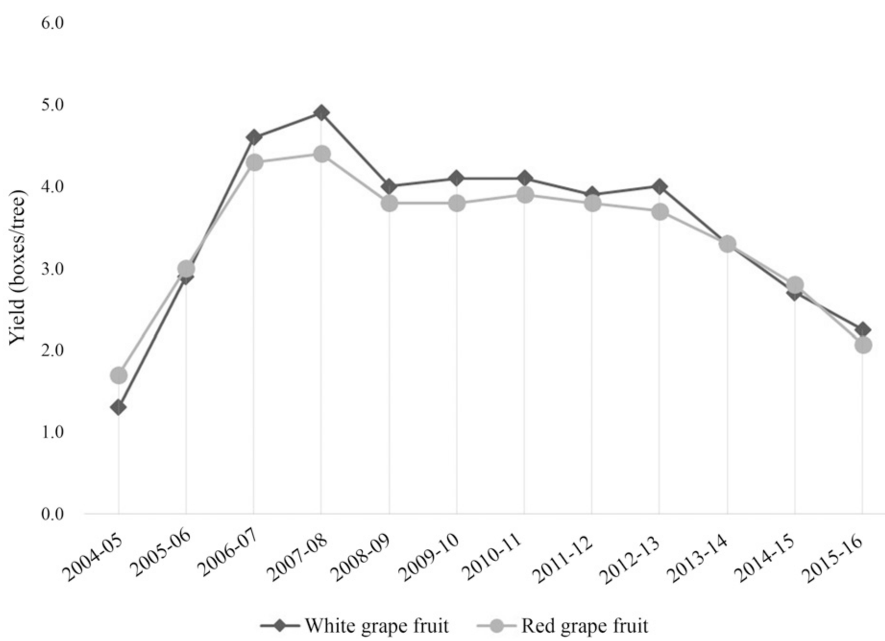

Fig. 2. Huanglongbing has had an adverse impact on grapefruit production yields as reflected by the significant decline of the weighted average grapefruit production yields [85-lb (38.56 kg) boxes/tree] from the 2004–05 season through the 2015–16 (forecasted) season; the severity of the decline has especially been observed since the 2008–09 season (National Agricultural Statistics Service, 2015).

over the entire life of the investment. It is also called the discounted cash flow method."

Often, the internal rate of return (IRR) is used as an application of the NPV calculation. Stated simply, IRR is the discount factor associated with an NPV of zero over a fixed planning horizon (Kay and Edwards, 1999). In this analysis, a 20-year investment horizon is used. Under current production practices, trees reach their maximum yield at ages ranging from 10 to 15 years. Unless affected by HLB, tree life in Florida can extend well beyond 30 years.

The formula for NPV is

$$\mathrm{NPV} = \sum_{0}^{20} \frac{R_t}{(1 + r)^n}$$

where R_t is the net return realized in year t and r is the discount factor.

R_t is negative for the first several years, as a citrus tree normally does not produce a marketable crop until its fourth year of life. Therefore, R_0 is the cost of new grove establishment including the cost of new trees, labor associated with planting, cost of irrigation equipment (irrigation lines and emitters), and other land preparation costs plus the cost of grove care in the first year after planting. In this analysis, it is assumed that the land being planted was previously used for citrus production such that all supporting infrastructure is already established. Additional land preparation costs are also not included such as the preparation of beds and ditches for drainage.

Incentives to encourage new citrus investment

Industry impetus to encourage new plantings has been proactive in recent years. Several organizations have developed programs intended to stimulate new grove investment in Florida. These programs are discussed in this section.

Profitability of new grove investment is affected by several factors, but the most important factors are productivity (fruit yields), fruit prices, initial cost of the investment, grove maintenance costs, and length of time needed to recover investment costs through depreciation. Programs that have been developed deal with all of these factors except productivity and grove maintenance costs. Declining yields associated with HLB is the primary factor driving reduced investment in new groves.

Expedited depreciation. Expedited depreciation for income tax purposes allows for earlier deduction of the cost of new investment earlier

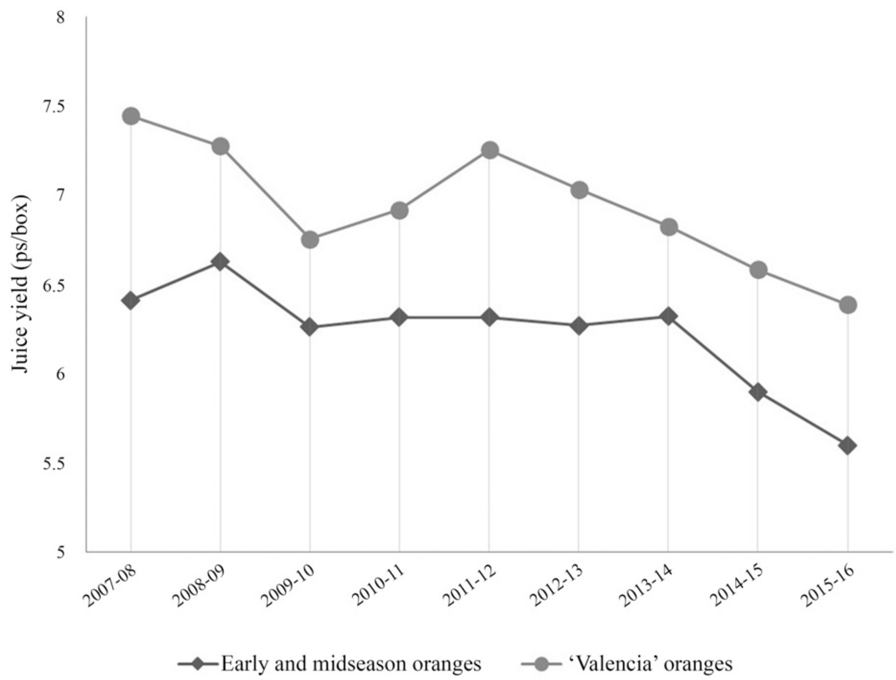

Fig. 3. Huanglongbing has had an impact on fruit quality as reflected in the decline in juice yields [pounds solids (ps) per box] for processed early- and midseason and 'Valencia' orange juice yields experienced a constant decline from 2007–08 season through the 2015–16 (forecasted) season (Florida Department of Citrus, 2016); 1 ps/90-lb (40.82 kg) box = 0.0245 ps/kg.

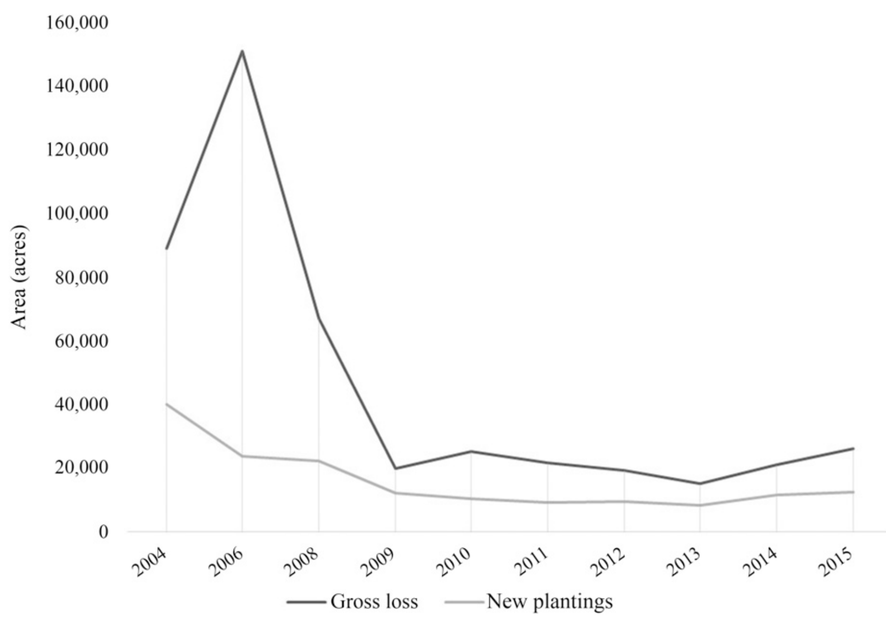

Fig. 4. New citrus tree plantings in Florida have been less than 50% of tree mortality/removal rates since 2009 as noted by the rate of decline in the Florida commercial citrus tree inventory (National Agricultural Statistics Service, 2015); 1 acre = 0.4047 ha.

in the life of the grove. Under present Internal Revenue Service (IRS) rules, the cost of new grove establishment cannot be depreciated until fruit income is realized. This means that if a new grove was planted in early 2016, all planting costs plus grove care costs from 2016, 2017, and 2018 are tallied. Assuming a marketable crop is produced in 2019, a 10-year straight-line depreciation schedule is initiated on total capital costs incurred in the 2016 through 2018 period. Thus, not until 2028, or 13 years after planting, are costs finally recaptured for tax purposes. Expedited depreciation is the basis of a proposal of a recently introduced bill by U.S. Representative Vern Buchanan of Florida (Bouffard, 2015). Under the proposed legislation, instead of accumulating new grove establishment costs and grove maintenance costs during the nonbearing portion of grove life, for tax purposes, the costs would be "expensed" or written off in the year incurred. As such, the ability to recapture costs associated with new grove development occurs much earlier in the planning horizon.

A modification of this approach, known as bonus depreciation, has been allowed by the IRS in the 2014 and 2015 tax years. Under bonus depreciation, 50% of the cost of new trees can be expensed in the year in which they are planted. All other costs, labor associated with new planting, irrigation equipment, land preparation, and grove maintenance until fruit income is realized, are treated as specified in current rules.

LONG-TERM ESCALATING PRICE FLOOR. In 2012, Minute Maid, one of the largest juice marketing brands and owned by Coca-Cola, with headquarters in Atlanta, GA, put forth a long-term contract. Growers were asked to make a 20-year commitment for new grove plantings only. The contract established a price floor of $1.90 per ps for early- and midseason fruit and $2.10/ps for 'Valencia' oranges for years 1 through 10, increasing to $2.00/ps for early- and midseason oranges and $2.20/ps for 'Valencia' oranges in years 11 through 15, and increasing to $2.10/ps and $2.30/ps for early- and midseason and 'Valencia' oranges, respectively, in years 16 through 20.

The price paid is subjected to a rise tied to the Florida Department of Citrus (FDOC) post estimate fruit price (also known as by the acronym DOCPER) and a price ceiling of $2.30/ps for early- and midseason oranges and $2.50/ps for 'Valencia' oranges in years 1–10. The price ceiling increases by $0.10/ps in years 11–15 and increases again by $0.10/ps in years 16–20. This program hereafter is called the "long-term escalating price floor" plan.

New grove investment incentives. Two programs were established to reduce the cost of new citrus grove development in Florida. One program is funded through the USDA and is known as the Tree Assistance Program (TAP). The other program is sponsored by Florida's Natural, one of the major processing companies in the state that operates as a grower-owned cooperative. Florida's Natural is located in Lake Wales, FL. The program is open to cooperative members only.

The TAP is a program administered through the Farm Services Administration (FSA) and provides financial assistance to those growers willing to invest in new grove development. FSA in Florida has offices located throughout the state, but its main office is in Gainesville, FL. The current TAP program, offered to citrus growers, reimburses growers for replanting trees/acreage lost to the effects of HLB. This program reimburses a portion of the cost of the trees, planting costs, and land preparation costs.

There are a number of eligibility provisions and payment constraints that limit widespread use of this program. In general, this program is beneficial for small- to medium-sized growers. To qualify, the average adjusted gross income of the individual or entity cannot exceed $900,000. In addition, a grower must demonstrate that they have incurred tree losses of at least 18% on a particular block due to HLB.

The TAP program received 1830 applications from 668 participant individual/entities with an average payment per application/notice of loss of over $13,000 each through Apr. 2016. The current number of applications covers close to one million trees worth of reimbursements. Strengthening and refining this program could make a substantial difference to the tree planting trajectory in Florida so that program reaches the FSA goal of six million trees planted by 30 Sept. 2018 when the current U.S. farm bill will expire. The FSA has improved its efforts recently to increase participation in the TAP program.

In 2013, Florida's Natural, one of three major orange juice brands in the United States and the largest processing citrus cooperative in Florida, put forth a program that combined elements of the Minute Maid and TAP programs. Under the Florida's Natural program, growers are given an interest-free loan of $10/tree for each tree planted in a new development (money may not be used for resets within an existing grove). Growers then are asked for a 13-year commitment, 3 years for the nonbearing portion, and 10 years of bearing life. Each year that fruit delivery is made, one-tenth of the loan is written off (or forgiven) which is treated as taxable income. After 10 years of fruit delivery, the entire loan is forgiven. To date, Florida's Natural executives indicate that 100% of their goal of one million new trees has been fully subscribed, but not all trees have been planted as of the 2015–16 season. This approach is referred to hereafter as "supported investment."

It should be noted that the supported investment program did not preclude a grower also applying to the TAP program. It is not known how many, if any, growers actually applied and received assistance from both programs.

Economic analysis of processed oranges

Each of the five programs outlined are analyzed using an IRR analysis and compared against a baseline. Early- and midseason oranges and 'Valencia' oranges are analyzed separately. New grove investment is assumed to occur on land previously used for citrus so that land preparation charges are assumed to be $400/acre and the costs for new irrigation are assumed to be $1000/acre. Therefore, the presence of a well or other water source is assumed. New trees are assumed to cost $7.50 each and planting costs are $3.00/tree, totaling $10.50/tree. Grove maintenance costs are assumed to be $1200/acre in year 1, $1600/acre in year 2, and $1800/acre in year 3. Under 2013 IRS rules, total investment costs are $8363/acre assuming a tree density of 225 trees/acre that can be depreciated beginning in year 4 (the first year that fruit income is realized). These costs are based on estimates provided by Singerman (2015a) combined with an informal survey of growers and extension agents.

Per tree fruit and juice yields are those used by Spreen and Zansler (2015) in their 2015 projection for future citrus production in Florida and represent yields from the 2014–15 season. Per tree fruit yields by age are shown in Table 1. These figures were computed by the authors using the 2013–14 per tree yields published by NASS (2016b) and updated to reflect the actual 2014–15 crop. Yields for early- and midseason and 'Valencia' oranges reflect the central region as defined by NASS (2016b); the red grapefruit yields are the Indian River yields. The Indian River region accounts for a large proportion of grapefruit produced in Florida.

The age categories used in Table 1 required further explanation. NASS (2016b) publishes per tree yields in age category ranges: ages 4 through 6 years, ages 7 through 13 years, ages 14 through 23 years, and ages 24 years and older. Under current production practices, per tree yields begin to level off around 2012–14 years of age. Since this analysis covers the first 20 years of tree life, per tree fruit yields from ages 1 through 20 years are shown in Table 1.

Many new plantings are at higher tree densities. Therefore, a density of 300 trees/acre is also analyzed. Higher tree densities increase the cost of new grove investment since more trees are required. It is not clear the effect of higher densities on grove maintenance costs; here it is assumed that a density of 300 trees/acre increases grove maintenance costs by $100/acre compared with 225 trees/acre in years 1, 2, and 3. Grove maintenance is assumed to be $2100/acre for trees ages 4 years and older at 225 trees/acre and $2200/acre at a density of 300 trees/acre. Pick and haul charges are assumed to be $2.75/box for early- and midseason oranges and $2.85/box for 'Valencia' oranges (Singerman, 2015a).

It should be noted that there are two concerns regarding the assumptions on caretaking costs. First, grove maintenance costs for trees ages 4 through 6 years may be overstated. Second, the effect of increasing tree density from 225 to 300 trees/acre may increase caretaking costs by an amount different from $100/acre.

With smaller crops, recent fruit prices have been close to the price floor of the long-term escalating price floor plan. To provide some contrast, in the baseline scenario,

Table 1. The average number of boxes of citrus harvested per tree are used to project future citrus production in Florida are disaggregated by tree age and citrus cultivar/type for the Florida 2014–15 season (Spreen and Zansler, 2015).

Tree age (years)	Early- and midseason oranges yield (90-lb boxes/tree)[z]	'Valencia' oranges yield (90-lb boxes/tree)	Red grapefruit yield (85-lb boxes/tree)[z]
1–3	0	0	0
4	0.35	0.2	0.7
5	0.65	0.35	0.9
6	0.9	0.5	1.1
7	1.1	0.7	1.3
8	1.3	0.9	1.5
9	1.5	1.1	1.7
10	1.7	1.3	1.9
11	1.85	1.5	2.1
12	2.0	1.7	2.3
13	2.1	1.8	2.5
14–20	2.1	1.8	2.7

[z]1 lb = 0.4536 kg.

fruit prices are assumed to be $1.80/ps for early- and midseason oranges and $2.00/ps for 'Valencia' oranges. A 20-year planning horizon is evaluated given that the supported investment program requires 13 years and the floor price in the long-term escalating price floor contract does not rise until year 11.

Results and discussion for processed oranges

The baseline results are summarized in Table 2. Estimated IRR is shown for each of four combinations of tree density (225 and 300 trees/acre and cultivar—early- and midseason and 'Valencia' oranges). The estimated IRR for both cultivars improve with higher tree densities. At a tree density of 225 trees/acre, estimated IRR is 3.59% for early- and midseason oranges and 3.12% for 'Valencia' oranges, respectively. At a density of 300 trees/acre, estimated IRR is higher, 7.68% for early- and midseason oranges and 6.95% for 'Valencia' oranges, respectively. Despite the positive estimated returns at higher tree densities, returns are still projected well below the level most investors would deem to be acceptable. These results confirm why the industry has seen low levels of new grove development. The primary reasons that low IRRs are estimated is a combination of low per tree fruit yields and increased grove maintenance costs. Both of these factors are a consequence of HLB and may be mitigated with scientific advancements.

Both expedited and bonus depreciation of new grove investment have been promoted as means to stimulate new plantings. The estimated results, as shown in Table 2, indicate that both programs provide some increase in estimated IRR. For both approaches, the same pattern as observed for the baseline results, namely higher IRR, is associated with high per acre tree densities. The estimated IRR under both plans, however, is higher compared with the baseline. Expedited depreciation for early- and midseason oranges planted at 300 trees/acre show an estimated IRR of 9.16% compared with 7.68% in the baseline. The estimated IRR for 'Valencia' oranges under expedited depreciation show a comparable advantage compared with the baseline at 300 trees/acre.

The results shown in Table 2 of the long-term escalating price floor plan showed elevated estimated IRR. Under all four scenarios considered, the long-term escalating price floor plan showed estimated IRR that are ≈2% points higher across cultivars and densities. At a tree density of 225 trees/acre, estimated IRR was 5.73% for early- and midseason oranges and 4.93% for 'Valencia' oranges, respectively. A tree density of 300 trees/acre gave an estimated IRR of 9.47% for early- and midseason oranges and 8.47% for 'Valencia' oranges, respectively. The estimated IRR associated with 300 trees/acre are more aligned with what an investor would expect from investing in new grove plantings.

The overall scope of the TAP and the supported investment program are essentially the same with key differences. Although both provide the grower with up-front advanced assistance for new grove development, the TAP program places significant limitations on program participation that is largely based on farm size. At the same time, TAP is considered a grant with no repayment provisions as long as the eligibility criteria are met. The level of support provided by the TAP program depends on the number of trees eradicated to make a new block eligible for a new solid-set planting.

In this analysis, it is assumed that the old block is planted at 145 trees/acre that had become the standard density in much of the 1990s and first decade of the 2000s and at least 18% of the trees are infected to meet the eligibility criteria. The grower is compensated for 65% of the cost of replanting based on the old density less an 18% deduction for the infected trees. In the example here, ≈118 healthy trees would need to be eradicated. The figure times $10.50/tree (cost of new tree plus planting cost) times 0.65 gives a compensation of $811.49/acre. The program also covers 50% of the land clearing costs, which are assumed herein to be $400, so that total compensation for the tree density levels considered here is $811.49 plus $200.00, which equals $1011.49/acre.

The supported investment plan has repayment provisions that are waived as long as the fruit from the new planting remains committed to Florida's Natural. The level of the cash award under the supported investment program is higher than the TAP plan and varies based on the density of the replanted grove. The cash awards from both programs are subject

Table 2. Estimated internal rate of return (IRR) of baseline and alternative tree planting incentive programs for new plantings at various grove densities of processed early- and midseason oranges, processed 'Valencia' oranges, and fresh-market red grapefruit.

	Early- and midseason orange		'Valencia' orange		Red grapefruit	
	Grove density (trees/acre)^{z}					
	225	300	225	300	150	225
Program	IRR (%)					
Baseline	3.59	7.68	3.12	6.95	–0.78	7.46
Expedited depreciation	4.51	9.16	3.88	8.20	–0.5	9.12
Bonus depreciation	4.19	8.55	3.73	7.87	–0.79	7.57
Long-term escalating price floor	5.73	9.47	4.93	8.47	n/a	n/a
Tree assistance program	4.52	8.63	4.85	7.80	–0.25	8.21
Supported investment	5.61	11.11	4.89	9.94	0.12	9.91

^{z}1 tree/acre = 2.4711 trees/ha.

to income taxes, although the timing of the tax burden differs. An additional benefit to the grower, and one that enhances the incentive to reinvest in replanting, is that eligible growers can participate in both programs.

Under the two planting densities considered, both plans show estimated IRR that for the TAP plan is ≈1% point higher compared with the base, although that advantage grows larger at a density of 300 trees/acre. Under the supported investment plan, the increase in IRR is ≈2% points; early- and midseason oranges planted at 300 trees/acre have an estimated IRR of 11.11%.

Another scenario was considered under which it is assumed that per tree yields increase by 20% across both cultivars and all tree age classes. These results are shown in Table 3 under the baseline scenario assumptions only. Increasing yield by 20% has a marked effect on estimated IRR increasing by more than 3% across all four scenarios. This result provides more evidence on two fronts: first, the negative impact of HLB on the economics of new grove investment, and second, the need to implement solutions to HLB that would have modest benefits on tree productivity.

In summary, expedited depreciation provides relief to investors in Florida oranges. The positive increases in IRR shown by the estimates in Table 2, especially when combined with other programs, support the implementation of these important programs for growers to enhance the overall IRR of any initiative. A long-term escalating price floor approach offers assistance. Upfront cash awards for new grove development is an approach that also offers assistance, although the two programs analyzed are subject to limited participation. The price/ps guaranteed in the long-term escalating price floor plan, although higher in 2012 when the plan was first proposed, is close to the price/ps observed over the last two seasons.

Analysis for grapefruit

Analysis of new grove investment for grapefruit differs from processed oranges since a portion of the crop is sold in the fresh market. Grapefruit also show different yields compared with oranges. Fresh-market grapefruit also incur higher caretaking costs since external appearance is important; the threat of citrus canker (*Xanthomonas axonopodis* pv. *citri*) is also an issue. It is also unlikely that grapefruit will be planted at densities of 300 trees/acre, thus only densities of 150 and 225 trees/acre are considered.

With respect to the five programs analyzed for processed oranges, all are applicable to grapefruit except the Coca-Cola/Minute Maid plan, which is intended for processed oranges only. Therefore, a long-term escalating price floor plan is not considered in this section.

Grove establishment costs are the same as those assumed in the processed orange analysis. Caretaking costs, however, are assumed to be \$2200/acre for a mature grove planted at 150 trees/acre and \$2400/acre at a tree density of 225 trees/acre. Per tree yields from the 2014–15 season for red seedless grapefruit are used. The analysis, however, could be easily modified to account for white seedless grapefruit grown for the fresh market in the Indian River area. In a similar manner, this framework could also be adapted for other fresh-market cultivars such as Washington navel oranges, early- and late-tangerines, as well as the new mandarin cultivars [e.g., Blanco (*C. reticulata*)]; caretaking cost in the first 3 years of tree life are assumed to be \$1450, \$1650, and \$1850 per acre for years 1, 2, and 3, respectively, for groves planted at 150 trees/acre. The costs are assumed to be \$1600, \$1800, and \$2000 per acre, respectively, for the first 3 years for groves planted at a tree density of 225 trees/acre. Packout (percent suitable for the fresh market) is assumed to be 65%. Pick and haul costs are \$2.85/box, fresh fruit packing costs are \$5.36/42.5-lb carton (Singerman, 2015b), and free on board fresh fruit price is assumed to be \$12.00/carton. The estimated elimination value is based on juice yields ranging from 4 ps/box at age 4 up to 4.6 ps/box at age 10. The elimination charge is \$1.42/box (Singerman, 2015b). The delivered-in prices for processed red grapefruit are assumed to be \$1.88/ps, the 2015–16 average price for grapefruit sent for processing (FDOC, 2016).

Results and discussion for grapefruit

The results from the baseline, expedited depreciation, bonus depreciation, TAP, and Florida's Natural scenarios are also shown in Table 2. The TAP results assume that the infected grove was planted at a density of 130 trees/acre. Based on an infection rate of 18%, the estimated compensation would be \$923.45/acre. The first result of note is that across all scenarios, the estimated IRR is comparable for fresh-market grapefruit compared with processed oranges. At a density of 150 trees/

Table 3. The estimated internal rate of return (IRR) of baseline scenario for processed oranges across cultivars and tree densities is determined under a scenario where yields of fruit per tree are 20% higher.

	Grove density (trees/acre)[z]	
Orange cultivar	225	300
	IRR (%)	
Early- and midseason	7.15	10.85
Valencia	6.44	9.90

[z]1 tree/acre = 2.4711 trees/ha.

acre, all of the estimated IRRs are negative except for the supported investment plan, which was 0.12%. All of the estimated IRRs at densities of 225 trees/acre are positive ranging from 7.46% to 9.91%. These results are obtained using fruit yields from the Indian River area that are lower than the other regions of the state. Estimated IRR would be higher using yields from other production regions.

For grapefruit, both bonus depreciation and expedited depreciation show some benefit in increasing IRR with the increase for expedited depreciation being substantial at a density of 225 trees/acre. Both new planting assistance programs, TAP and supported investment, provide increases in IRR compared with the baseline with the supported investment plan giving an estimated IRR of 9.91% at a tree density of 225 trees/acre. It should be noted that the Florida's Natural Plan, now, does not include grapefruit. It is analyzed here for illustrative purposes only.

Limitations

One notable result is that across all cultivars and incentive plans, higher tree densities gave higher estimated IRR. This result may show the need for growers to increase tree density in new plantings. It may also be a consequence of the assumptions made herein. Per tree yields used at a density of 300 trees/acre (for oranges) may overstate fruit production per acre, especially at older ages. This phenomenon is reminiscent of what occurred in the 1990s after the freezes of the 1980s and tree density was increased from 80 to 100 trees/acre to the now standard density of ≈145 trees/acre. As those groves matured, it became apparent that per tree yields from groves at 80–100 trees/acre could not be extrapolated to higher density plantings.

As a consequence of disease impacts, including HLB and citrus canker, per tree yields have declined substantially over the past several seasons so that extrapolation of these lower yields may not overstate tree productivity at higher densities.

Another issue is caretaking costs. Even though higher caretaking costs are assumed at higher tree density, the costs assumed herein may understate the actual increase in caretaking costs as tree population per acre increases. In such cases, returns may be overstated at higher tree densities.

Summary and conclusions

In this paper, an analysis of several programs whose intent is to stimulate new plantings of citrus in Florida is presented. The five programs considered address different aspects of the tree planting decision. Present IRS regulations provide for what is called bonus depreciation of new plantings, which allows an immediate write-off of a portion of the cost of new trees. There is proposed legislation that would greatly alter the tax treatment of new plantings and allow all expenses related to new grove investment to be "expensed" in the year realized instead of depreciated over a 10-year period beginning when the first crop is harvested (generally year 4 after planting). The results of the analysis here are that both of these programs would provide benefits for both processed orange and fresh-market grapefruit investment.

A second approach is a long-term fruit contract with a long-term escalating price floor as proposed by Coca-Cola/Minute Maid in 2012. Analysis of this approach provided some increase in estimated IRR for processed oranges. The present plan is not applicable to fresh-market grapefruit.

The third approach is a new grove investment assistance program. The TAP program provides funds to cover a portion of the cost of land preparation and compensation for trees lost. The supported investment program provides a $10/tree no interest loan for new grove development. The loan is forgiven over a 10-year period as long as the fruit remains with Florida's Natural. The supported investment program provides a higher level of assistance compared with TAP and therefore shows higher IRR. Given the limits in the TAP programs, it shows a smaller increase in estimated IRR compared with the supported investment plan across all cultivars and tree densities analyzed.

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