The Economics of Restoring Florida's Commercial Orange Tree Inventory

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Abstract

This study provides a quantitative measure of the benefits associated with restoring Florida's commercial orange tree inventory under three scenarios in which new plantings occur across various densities. Two alternative management strategies, traditional production and advanced production systems (APS), across 3 scenarios are considered for new plantings. The results are used to evaluate a variety of potential outcomes for growers, juice processors and the state under three planting scenarios: 100% APS, 100% Traditional, and 50/50 APS-Traditional plantings. An economic impact analysis is conducted to estimate the total impacts associated with new production. The results indicate significant benefits across all replanting efforts with a higher rate of production with the APS commercial tree inventory. Direct industry output impacts over a full 20-year horizon ranged from $10.34 billion to $11.79 billion, including $4.40 B to $5.00 B to growers and $5.94 B to $6.79 B to juice processors, across the three scenarios.

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Introduction

The Florida citrus industry was the leading producer of citrus in the United States (U.S.) for several decades, providing significant economic contributions to the communities within which it operates and beyond. During the 2003-04 citrus season, the Florida orange crop reached 242 million boxes[4] and boasted a commercial orange inventory of nearly 83 million trees. Since that season, the citrus industry has encountered several setbacks that threaten its long-term viability, including but not limited to numerous natural disasters and the spread of harmful plant pathogens. In 2004 and 2005, the paths of four hurricanes crossed the citrus-producing regions of Florida and caused widespread production losses. While the hurricanes did not cause extensive tree loss, they did serve to spread both citrus canker and Huanglongbing (HLB, also known as citrus greening). Citrus crops rebounded modestly after these hurricanes but the negative impact of the two diseases, HLB in particular, were measurable by the 2010-11 season.

As a result of these setbacks, competition for land with urban development, and new regulations on nursery production, the citrus industry has witnessed declines in commercial orange tree inventory, fruit production, and the rate at which new trees are planted. Between 2004 and 2016, the commercial orange tree inventory has declined by 30% or nearly 25 million trees and orange production has fallen by nearly 72% from 242 million boxes of oranges produced during the 2003-04 season (USDA-NASS). The replanting rate, the ratio of the percentage of newly replanted trees compared to the tree loss rate each year, fell below 50 percent for several years following the tumultuous hurricane seasons in 2004 and 2005. Despite this decline, the Florida citrus industry continues to provide significant economic contributions to the communities that are home to industry operations and beyond. The 2015-16 Florida citrus season provided an estimated $8.6 billion in industry output, including $2.118 billion from citrus fruit production, $6.207 billion from citrus juice manufacturing, and $308 million from fresh citrus marketing. Furthermore, the citrus industry supported a total of 45,422 fulltime and part-time jobs in the state during the same time period and provided more than $270 million in state and local tax contributions (Court, et al. 2017). With a well-established infrastructure in key agricultural areas of Florida and new HLB-mitigating measures on the horizon, industry stakeholders are evaluating options to restore the commercial orange inventory and ensure that the industry remains a vital economic driver in the state.

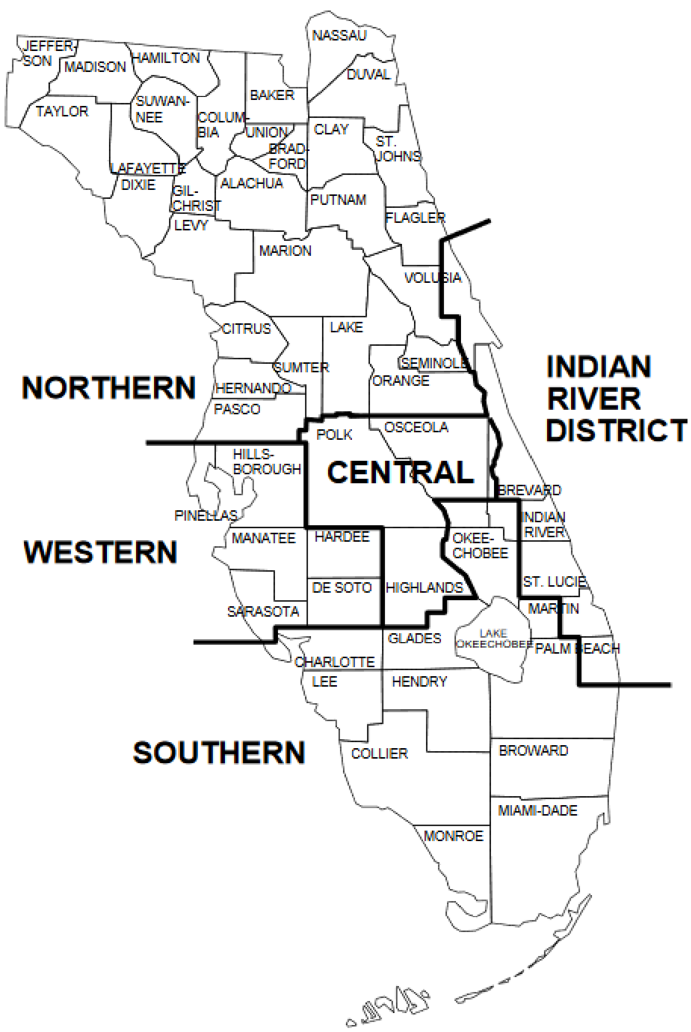
The overall objective of this paper is to evaluate the economic benefits associated with new fruit and juice production for a variety of scenarios that are expected to reverse the decline of citrus production in the state.

[4] 90-pound boxes

Commercial Orange Production

The most favorable climate conditions for commercial orange production in Florida are located in the lower two thirds of the peninsula, with the exception of the southernmost region, which is covered by the Florida Everglades. Figure 1 illustrates the five production zones as defined by the U.S. Department of Agriculture's National Agriculture Statistics Service (USDA-NASS): Northern, Central, Indian River, Western, and Southern.

Figure 1. Florida commercial citrus production zones



Source: NASS-USDA, Southern Region, Florida Field Office.

Processed orange trees in Florida fall into two main categories: early and midseason maturing (called early-mids) and late maturing or Valencia oranges. The early-mid harvest generally begins in late November and extends to the end of February. The Valencia harvest takes place between March and June. Compared to Valencia oranges, early-mid varieties generally produce more boxes per tree but with lower juice content per box. New varieties of early-maturing, Valencia-type orange varieties that have recently entered the market can be harvested as early as December. Since the fruit and juice yield from these varieties are closely related to Valencia varieties harvested in the late season, they are treated as Valencia in this analysis.

Historically, most of the citrus production area of Florida was more oriented to processed orange production. The exception was the east coast or Indian River production area that extends along the Atlantic coast from south of Daytona Beach to Palm Beach. The Indian River area was able to establish Indian River grapefruit as a recognizable regional trademark that was valued in the fruit trade. The other four production regions: North, Central, Western, and South were more focused on processed orange production although fresh fruit varieties such as tangerines, temples, tangelos, and grapefruit were also grown there.

Changing Structure of the Industry

The subtropical climate of the upper central to the lower Southwest peninsula of Florida provides ideal conditions for growing citrus. The production of citrus expanded rapidly from the 1940s to the 1980s across all five production regions.

A series of events, beginning with a series of hard freezes in the mid-1980s, resulted in industry structural and regional shifts in production over a 30-year period. The commercial citrus tree inventory during this time was framed by an upper interior that was as far north as Marion County. Florida citrus production and the commercial tree inventory were negatively impacted following the weather freezes that occurred in December 1983 and January 1985. From 1988 to 2000, Florida citrus growers planted nearly 33 million net new trees, and the tree replacement rate exceeded 100% replacement of tree losses during the same period. By 2000, the commercial orange tree inventory exceeded 87 million trees with nearly 79 million bearing trees that produced 233 million boxes of oranges. In addition, the rate of tree replacement increased at a rate higher than the rate of replanted acreage suggesting higher tree densities per acre. Another effect of the freezes was a reduction in citrus production in north-central Florida (Marion, Lake, and Orange counties) and an increase in production to the south, especially southwest Florida (Hendry, Desoto, Hardee, and Collier counties).

Around this period, several factors began to impact the structure of the processed orange industry including higher demand for land used for urbanization, reduced grower profitability associated with the higher supply, structural shifts in the processing industry away from FCOJ to NFC, the emergence of citrus canker, and the tumultuous hurricane seasons of 2004 and 2005. Although HLB was first discovered in Florida in 2005, its deleterious effects on Florida citrus production began to be seen by the 2010-11 season. The impact of HLB reaches beyond the farm gate to other segments of the industry. Producer uncertainty surrounding HLB mitigation measures, especially in recent years, is also a contributing factor. Since 2004, the low replant rate and the decline in tree yields due to HLB have affected both commercial acreage and fruit production levels. By 2016, the Florida orange tree inventory and current fruit per tree yields have fallen below an inventory level necessary to meet U.S. market demand.

The tree replanting effort that followed the hard freezes gradually shifted the production region southward, and tree density per acre increased from an average of 80-90 trees per acre to approximately 145 trees per acre.

Another factor affecting the commercial tree inventory in the northern portion of the "citrus belt" was displacement by rapid urbanization with growth of Orlando and Tampa-St. Petersburg-Clearwater over the past 30 years. Considerable urban growth along both the Atlantic and Gulf coasts has also reduced the size Florida's agricultural lands.

The decline in the commercial orange tree inventory has been quite severe since 2004 as the industry endured the fallout from hurricanes and HLB with a 37 percent decline in acres of early-mids and a 28 percent decline in acres of Valencia with the largest declines occurring in in the Indian River and Northern production areas.

More recently, the commercial orange tree inventory declined by eight percent between 2013 and 2016, which has severely limited the prospects of reaching an orange crop in excess of 100 million boxes. Florida produced 53.3 million 90-lb boxes of early-midseason oranges and 51.4 million 90-lb boxes of Valencia oranges during the 2013-14 season. This level of production further declined to 33 million 90-lb boxes of early-midseason oranges and 35.9 million 90-lb boxes of Valencia oranges during the 2016-17 season. Table 1 and Table 2 exhibit the decline in citrus acreage and tree inventory between 2013 and 2016, disaggregated by the five production areas defined by the National Agriculture Statistics Service of the United States Department of Agriculture (NASS-USDA).

The decline in commercial tree inventory is linked to producer uncertainty with respect to HLB and an insufficient tree replanting effort, which have fallen below 100% tree replacement for every tree lost to production since the 2000-01 season. Figure 2 illustrates the replacement rate of the commercial orange tree inventory for early-mids and Valencia orange trees. The replacement rate is the difference in the loss rate and the replanting rate. The replacement rate is the year-over-year percentage change in commercial tree inventory and the replanting rate is the percentage of trees planted each season. When the loss rate exceeds the replant rate, the replacement rate is less than 100 percent.

Table 1. Florida orange acreage declined across all regions between 2013 and 2016.

Region	Non-Valencia Oranges			Valencia Orange		
	2013	2016	%-chg	2013	2016	%-chg
	acres			acres		
Indian River	11,061	7,417	-33%	20,497	12,368	-40%
Northern	13,704	10,438	-24%	5,308	3,910	-26%
Central	56,970	52,042	-9%	80,094	76,539	-4%
Western	68,285	63,940	-6%	64,583	63,515	-2%
Southern	50,489	48,040	-5%	81,288	75,953	-7%
Total	200,509	181,877	-9%	251,770	232,285	-8%

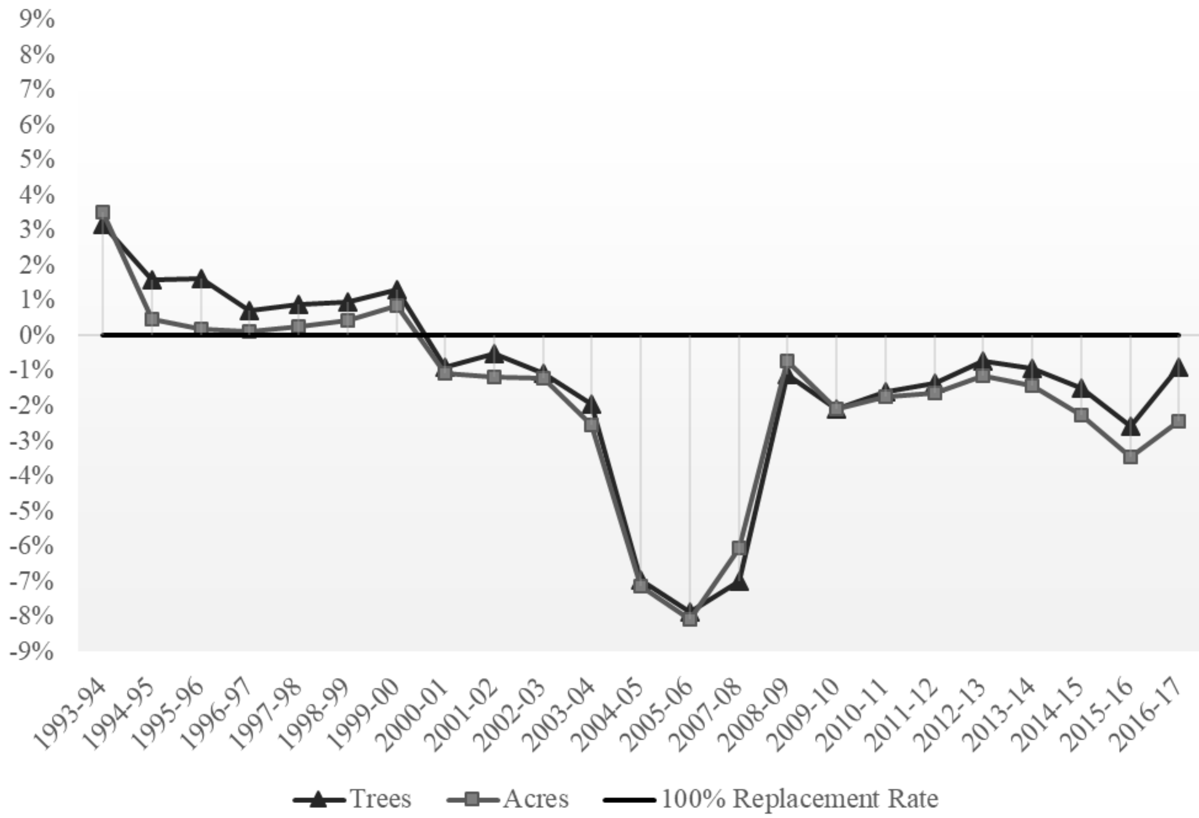
Source: National Agricultural Statistics Service. Florida citrus statistics: Various issues. U.S. Dept. Agr., Florida Field Office, Maitland, FL

Table 2. Florida orange trees declined across all regions between 2013 and 2016.

Region	Early and midseason oranges			Valencia Orange		
	2013	2016	%-chg	2013	2016	%-chg
	1,000 trees			1,000 trees		
Indian River	1,381	954	-31%	2,896	1,860	-36%
Northern	1,816	1,398	-23%	735	542	-26%
Central	7,135	6,611	-7%	9,953	9,720	-2%
Western	8,609	8,270	-4%	8,472	8,455	0%
Southern	7,191	6,906	-4%	12,066	11,340	-6%
Total	26,131	24,140	-8%	34,122	31,917	-6%

Source: National Agricultural Statistics Service. Florida citrus statistics: Various issues. U.S. Dept. Agr., Florida Field Office, Maitland, FL

Figure 2. Replacement rate for trees and acreage for seasons 1993-94 through 2016-17

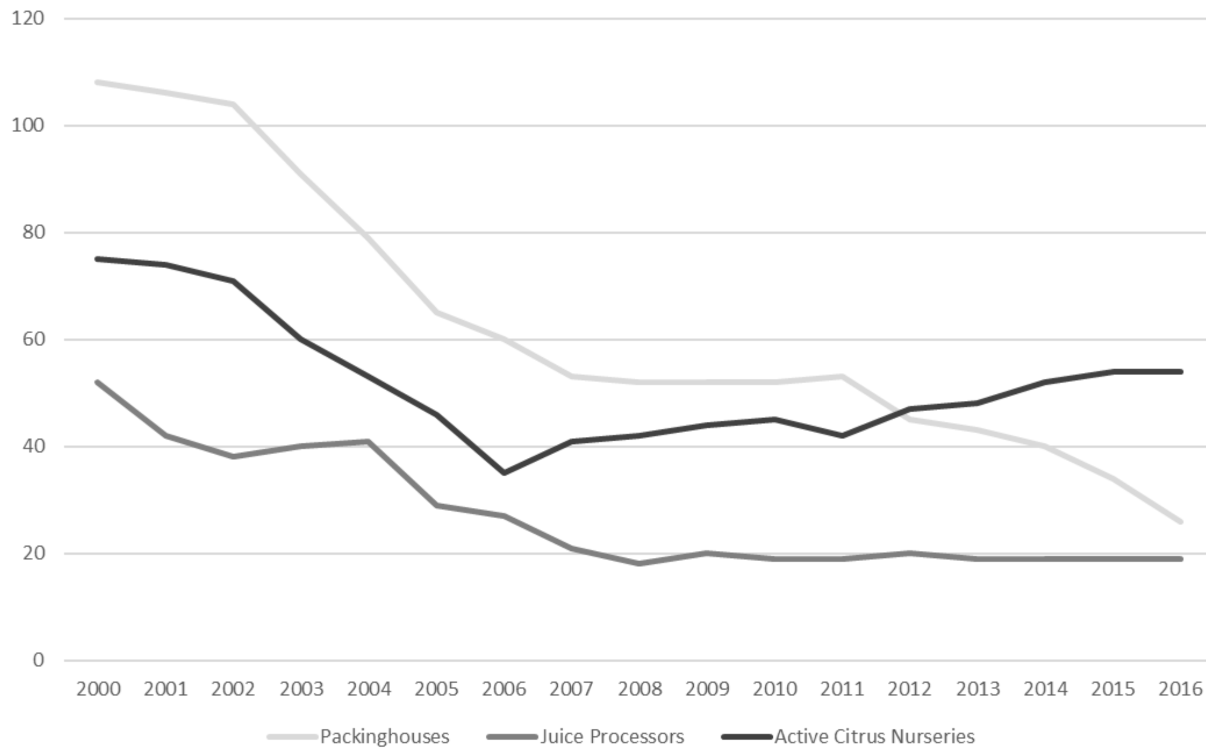


Without aggressive replanting strategies, orange production will continue to falter and impact the long-term sustainability of the industry in the State. The impact of declining production has had direct and indirect consequences on citrus infrastructure in the State. The number of Florida fresh citrus packinghouses and juice processors/bulk storage facilities[5] has declined from 108 and 52, in 2000, respectively, to 26 and 19 in 2016, respectively. The number

[5] "Bulk storage" is defined as storage, or storage capacities, of total quantities of processed citrus juice products in excess of fifty thousand (50,000) gallons stored in drums, bins, totes, barrels, or tank farms.

of licensed fruit dealers for processing raw citrus totaled 10 in 2016. The number of active nurseries in the State reached a peak in 2000 with 75 operations propagating citrus varieties. Following the 2004-2005 hurricanes and the implementation of regulatory measures intended to suppress the spread of citrus canker and HLB, the number of active nurseries fell to 35 in 2006. The number of active nurseries producing citrus nursery stocks, however, has since steadily increased with the emergence of best management practices for propagation and reached 54 active nurseries in 2016.

Figure 3. Number of Florida citrus packinghouses, juice processors, and active citrus nurseries



Restoring Florida's Commercial Orange Tree Inventory

Maintaining the economic contributions and impact of the Florida citrus industry is dependent upon restoration of the commercial tree inventory. Private and governmental incentive programs designed to stimulate replanting efforts were introduced in recent years to alleviate the uncertainty faced by producers. Industry stakeholders continue to evaluate options to restore the commercial orange inventory that will, ultimately, ensure that the industry remains a vital economic driver in the state. The management strategies often involve cost-sharing with processors.

Management Strategies

Two alternative management strategies are considered for new plantings: traditional production and advanced production systems (APS). The term traditional production refers to grove management strategies that have become standard after the freezes of the 1980s and have been in use for approximately 30 years. While current production practices vary from grower to grower, this analysis defines traditional production as commercial orange grove acreage that is planted with a spacing of 25 feet between the rows and 12 feet down the rows (25x12), resulting in an average tree density of 145 trees per acre.[6] Irrigation is assumed to be provided on an as needed basis by microsprinkler. Singerman (2016) estimates that production costs from grove maintenance only are approximately $1,820 per acre in 2014-15. Assumptions on the average yields per tree for traditional production, disaggregated by production region and variety, are shown in in APS for citrus was first developed in South Africa to combat the scarcity of water affecting much of that country's citrus industry. Under APS, tree density is much higher and can range from 272 trees per acre (20x8 spacing) to as high as 484 trees per acre (15x6 spacing). It was introduced to Florida in 2006 by Schumann, et al. (2009) with experimental plots planted soon thereafter. Due to the uncertainty caused by HLB, APS has not been widely adopted in Florida. Some Florida growers, however, have invested their own resources into trial APS planting strategies as an alternative to traditional production and are reporting positive results early on in the process. Larger processing facilities have also invested in trial APS groves and have willingly shared their results with industry. The advantages of APS include earlier production of fruit and potentially lower use of fertilizer. The primary disadvantage is higher initial investment costs as more trees per acre requires more investment in nursery trees and a more sophisticated irrigation system requires more investment compared to a traditional microspinkler system that is manually controlled.

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[6] Trees per acre are calculated as TPA= 43,560 sq. feet per acre ÷ (row width x row length).

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Estimated per tree yields for traditional planting disaggregated by variety and production region are shown in Table 3. These yield correspond to those used by Spreen and Zanlser (2016) in an analysis of production trends for Florida citrus. This analysis defines APS production as commercial orange grove acreage that is planted with an average tree density of 303 trees per acre (18x8 spacing). Irrigation is assumed to be provided by a dual irrigation system that is a combination of drip and microsprinker. In the early years of tree life, computers are used to pulse small amounts of water containing nutrients (a practice known as fertigation) daily. The premise is that "feeding" trees on a continuous basis accelerates tree growth.

Table 3. Average number of orange boxes harvested per tree for traditional plantings[a], disaggregated by tree age and citrus cultivar.

Tree age (years)	Early and midseason oranges Yield (90-lb (boxes/tree)[b]				'Valencia' oranges Yield (90-lb boxes/tree)[b]			
	Indian River	Central[c]	Western	South	Indian River	Central[c]	Western	South
1–2	0	0	0	0	0	0	0	0
3	0.15	0.3	0.4	0.4	0.2	0.3	0.4	0.5
4	0.35	0.5	0.7	0.6	0.4	0.5	0.6	0.7
5	0.45	0.9	0.9	0.8	0.6	0.7	0.8	0.9
6	0.55	1.05	1.05	1.0	0.7	0.85	0.9	1.0
7	0.6	1.15	1.15	1.3	0.7	1.0	1.1	1.0
8	0.7	1.3	1.3	1.6	0.7	1.1	1.3	1.0
9	0.8	1.45	1.5	1.7	0.7	1.3	1.4	1.2
10	0.9	1.55	1.7	1.8	0.7	1.5	1.5	1.4
11	1.0	1.7	1.9	1.9	0.7	1.7	1.6	1.6
12	1.1	1.85	2.1	2.0	0.8	1.9	1.7	1.8
13	1.2	1.95	2.3	2.1	0.9	2.0	1.8	1.9
14	1.3	2.0	2.3	2.2	1.0	2.1	1.9	1.9
15	1.3	2.1	2.3	2.3	1.1	2.1	1.9	1.9
16	1.3	2.2	2.3	2.3	1.1	2.1	1.9	1.9
17	1.3	2.2	2.3	2.3	1.1	2.1	1.9	1.9
18	1.3	2.2	2.3	2.3	1.1	2.1	1.9	1.9
19	1.3	2.2	2.3	2.3	1.1	2.1	1.9	1.9
20	1.3	2.2	2.3	2.3	1.1	2.1	1.9	1.9

[a] Traditonal plantings of 145 trees/acre
[b] 1 lb = 0.4536 kg
[c] Includes North region

Consequently, trees will produce fruit at an earlier age, reducing the time for the grower to recover investment incurred from planting a new tree. At older tree age, the microsprinker system will provide more water and nutrition as the demands of the tree increase. Microsprinklers also provide a high degree of freeze protection (see Parsons and Boman (2003, revised 2016) for the use of mircrospinklers in freeze protection in Florida citrus), which remains a concern for much of the citrus production belt in Florida.

Estimated yield per tree for APS by region and variety are shown in Table 4. The yields shown in Table 4 are estimated using information collected from an informal survey of three organizations that currently have APS plantings. As none of these plantings exceed five years of age, the yields shown for years 6-20 are somewhat speculative, but represent a composite of the information provided by those interviewed.

Table 4. Average number of orange boxes harvested per tree with high density plantings[a], disaggregated by tree age and citrus cultivar.

Tree age (years)	Early and midseason oranges Yield (90-lb (boxes/tree)[b]				'Valencia' oranges Yield (90-lb boxes/tree)[b]			
	Indian River	Central[c]	Western	South	Indian River	Central[c]	Western	South
1	0	0	0	0	0	0	0	0
2	0.25	0.35	0.35	0.35	0.25	0.25	0.25	0.25
3	0.5	0.8	0.8	0.8	0.3	0.45	0.5	0.5
4	0.7	1.0	1.0	1.0	0.4	0.9	0.9	0.9
5	0.9	1.5	1.5	1.5	0.5	1.3	1.3	1.3
6	1.0	1.9	1.9	1.9	0.7	1.9	1.9	1.9
7	1.1	2.1	2.1	2.1	0.9	2.0	2.0	2.0
8	1.1	2.1	2.1	2.1	1.0	2.0	2.0	2.0
9	1.1	2.0	2.0	2.0	1.0	1.9	1.9	1.9
10	1.1	1.9	1.9	1.9	1.0	1.9	1.9	1.9
11	1.1	1.9	1.9	1.9	1.0	1.8	1.8	1.8
12	1.1	1.8	1.8	1.8	1.0	1.8	1.8	1.8
13	1.1	1.8	1.8	1.8	1.0	1.8	1.8	1.8
14	1.1	1.7	1.7	1.7	1.0	1.8	1.8	1.8
15	1.1	1.7	1.7	1.7	1.0	1.8	1.8	1.8
16	1.1	1.7	1.7	1.7	1.0	1.7	1.7	1.7
17	1.1	1.7	1.7	1.7	1.0	1.6	1.6	1.6
18	1.1	1.7	1.7	1.7	1.0	1.6	1.6	1.6
19	1.1	1.7	1.7	1.7	1.0	1.5	1.5	1.5
20	1.1	1.6	1.6	1.6	1.0	1.5	1.5	1.5

[a] High density plantings of 303 trees/acre

[b] 1 lb = 0.4536 kg

[c] Includes North region

Scenarios Modeled

To evaluate a variety of potential outcomes for growers faced with the challenge of restoring Florida's commercial orange inventory, three production scenarios were analyzed:

1) A *Traditional* scenario in which all new orange plantings are assumed to be planted under the traditional production management strategy
2) An *APS* scenario in which all new orange plantings are assumed to be planted under the APS production management strategy
3) A *50/50* scenario in which 50 percent of the new orange plantings are assumed to be planted under the traditional production management strategy and 50 percent are assumed to be planted under the APS production management strategy

For all three scenarios, new plantings are assumed to be allocated 60 percent to Valencia (late) and 40 percent to early-mid varieties, which aligns with current inventory, nursery propagations, and production practices. Given the steeper decline in processed orange production in the Indian River and North regions, new plantings are assumed to be allocated at five percent in the Indian River zone, five percent in the North zone, 30 percent in the Central zone, 30 percent in the Western zone, and 30 percent in the South zone. Attrition rates are uniform across region, variety, and planting scenario with a 0.5 percent attrition rate in trees aged 2 to 3 years old, a 3 percent annual attrition rate for trees that are 4 through 15 years old, and an attrition rate that increase from 4 percent to 5 percent gradually each year for trees 16 years through 20 years. This analysis also assumes a 100% replant rate through year 7 across region, variety, and planting scenario. Finally, estimated juice yields, are assumed to be identical under both production systems. Juice yields by tree age and orange variety are shown in Table 5.

Methodology

The World Orange Juice Model

Fruit and juice production and prices were estimated using a mathematical model of world processed citrus market (Spreen et al., 2003). The model uses data on tree inventories, processor utilization, juice yields and market prices in Florida and Sao Paulo state in Brazil, the two largest regions for processed citrus production, to predict annual fruit and juice production, and grower and grower revenues in each production zone. The model allocates juice production in Florida and Brazil across the major markets of the U.S., European Union, Canada, and the rest of

Table 5. Average estimated juice yield in terms of pounds solids per box, by variety.

Tree age (years)	Early and midseason oranges	'Valencia' oranges
	Juice Yield (ps/90-lb boxes)[a]	
1	0	0
2	4.8	5.3
3	4.8	5.3
4	4.9	5.5
5	5.2	5.7
6	5.4	5.9
7–12	5.6	6.1

[a] 1 lb = 0.4536 kg

the world, accounting for transportation costs and tariffs to achieve a spatial price equilibrium. The impact of HLB is incorporated into the model through increased tree mortality rates (i.e., higher tree mortality rates in older trees), based on information from citrus experts at the University of Florida. The model also assumes there will be little variation in tree mortality across production zones, variety, and grove management strategies. Juice production is disaggregated into frozen concentrate orange juice (FCOJ and not-from-concentrate (NFC) production and prices for Florida oranges were projected over a 20-year time horizon for each of the three modeled scenarios.

Economic Impact Analysis

Using the fruit and juice production values and prices from the world orange juice model, an economic impact analysis was conducted using the IMPLAN© regional economic modeling system and the database for the State of Florida (IMPLAN© Group, LLC) to estimate the total economic impacts of the increased production activity. Total economic impacts of the new activity generated through grove restoration in Florida are measured by several metrics, including employment, labor income, value-added, industry output, and tax revenues.

Total economic impacts include economic multiplier effects that capture the additional economic activity generated by industry supply-chain activity and re-spending of income by households and governments in the local economy arising from the increased activity associated with fruit and juice production. Economic multipliers measure the total changes in an economy resulting from a given change in direct output or employment. There are three components of multipliers: direct, indirect, and induced effects. Direct effects represent the initial change in the industry of interest, indirect effects represent changes in inter-industry transactions as supplying industries respond to changes in demands from the directly affected industries, and induced effects reflect changes in local spending that result from income changes in employee and proprietor households and local, state, and federal governments.

The study region was defined as the state of Florida. Regional data from IMPLAN© used to model impacts for all years in this report represent the interindustry economic structure of 2016. The model was modified so as not to double count the value of fruit production when modeling increases in juice production. The model was constructed with social accounts for households, governments (state/local, federal), and capital investment internalized. Social Accounting Matrix (SAM) multipliers in IMPLAN© account for capital investment, taxes, and transfer payments such as social security, welfare, retirement pensions, and savings by household. This analysis used the Trade Flows model specification for estimating trade flows.

Two industry sectors in IMPLAN© were used to analyze the increased production: fruit farming (sector #4) and an aggregate sector representing both canned and frozen fruit and vegetable manufacturing (#79), which includes the production of fresh and frozen orange juice. These industry sectors are defined under the North American Industry Classification System (NAICS) based on the primary product or service produced or technology used. The output value of the increased fruit and juice production in each event year over the 20-year time horizon was specified as an impact event in the appropriate industry sector: increased orange production in the fruit farming sector and orange juice production in the canned and frozen fruit and vegetable manufacturing. Prices were adjusted for inflation to be entered into the model in event year dollars as opposed to constant dollars, assuming an annual average inflation rate of 2%.

Results

Fruit and Juice Production

Projected production levels are summarized in Table 6. Production under the *APS* scenario is accelerated to reach an additional 30 million boxes by year 11 and the *Traditional* scenario does not get close to this level until year 17. Thirty million additional boxes of production are never realized over a 20-year planting horizon in the *50/50* scenario due to the timing of peak production. APS plantings reach peak production earlier compared to traditional plantings and the sum of the production realized from each never reaches an additional 30 million boxes.

At peak production (year 11), the *APS* scenario produces 158 million additional SSE[7] gallons of juice whereas the *Traditional* scenario produces 134 million additional SSE gallons of juice at peak production (year 17). Florida orange juice production in 2016-17 was 387 million SSE gallons. A production increase of this magnitude would have a price effect in the domestic orange juice market.

Table 6. Additional orange production from new plantings, by variety and season.

Year	Traditional Plantings			High Density Groves			50% Tradition/50% APS		
	Early-mids	Valencia	Total	Early-mids	Valencia	Total	Early-mids	Valencia	Total
	-------------------- millions boxes --------------------								
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.4	0.4	0.9	0.2	0.2	0.4
3	0.4	0.7	1.1	1.3	1.2	2.6	0.9	1.0	1.8
4	1.1	1.7	2.8	2.5	2.8	5.2	1.8	2.2	4.0
5	2.0	3.0	5.1	4.2	4.9	9.0	3.1	4.0	7.1
6	3.2	4.5	7.7	6.2	7.9	14.2	4.7	6.2	10.9
7	4.4	6.2	10.6	8.5	11.1	19.6	6.4	8.7	15.1
8	5.9	8.0	13.9	10.3	13.8	24.1	8.1	10.9	19.0
9	7.1	9.3	16.4	11.4	16.0	27.4	9.2	12.7	21.9
10	8.0	10.5	18.5	12.2	17.4	29.5	10.1	13.9	24.0
11	8.8	11.4	20.3	12.4	17.9	30.2	10.6	14.7	25.3
12	9.5	12.4	21.9	12.0	17.3	29.4	10.8	14.9	25.6
13	10.1	13.3	23.4	11.4	16.6	28.0	10.8	14.9	25.7
14	10.6	14.1	24.7	10.7	15.8	26.5	10.6	14.9	25.6
15	10.9	14.7	25.6	10.1	15.2	25.2	10.5	14.9	25.4
16	11.1	14.9	26.1	9.6	14.4	24.0	10.4	14.7	25.0
17	11.2	14.9	26.1	9.1	13.7	22.8	10.1	14.3	24.4
18	11.0	14.6	25.7	8.6	13.0	21.6	9.8	13.8	23.6
19	10.7	14.2	24.9	8.2	12.1	20.3	9.5	13.1	22.6
20	10.3	13.6	23.9	7.8	11.3	19.0	9.1	12.4	21.5

[7] SSE stands for single strength equivalent and is the common measure used in Florida for citrus juices.

Projected juice production over the full 20-year time horizon and domestic FOB orange juice prices for each of the three modeled scenarios are shown in Table 7, Table 8, and Table 9. The presence of imports from both Brazil and Mexico has the effect of muting the price response associated with increased juice production in Florida. As Florida production increases, imports are reduced so the total available supply to the U.S. market increases by an amount less than the projected increase in Florida orange juice production. As shown in the three tables, prices only vary about 10 cents per SSE gallon over the 20-year period in constant dollar terms.

Table 7. Price impact of additional Florida orange juice production assuming new plantings are100 percent traditional.

Year	Production	On-Tree Price	OJ Production	FOB	
				FCOJ price	NFC price
	mil. boxes	$/box	mil. SSE gal.	$/SSE gal.	$/SSE gal.
1	70	11.86	389	1.73	3.18
2	70	11.86	389	1.73	3.18
3	71.1	11.82	402	1.73	3.18
4	75	11.75	414	1.71	3.16
5	77.7	11.36	428	1.65	3.09
6	80.6	11.62	445	1.69	3.14
7	80.6	11.62	445	1.69	3.14
8	84.9	11.54	460	1.68	3.12
9	86.4	11.46	477	1.67	3.12
10	88.5	11.41	490	1.66	3.11
11	90.2	11.37	501	1.65	3.10
12	91.9	11.33	510	1.65	3.10
13	93.4	11.29	519	1.64	3.09
14	94.7	11.26	526	1.64	3.08
15	95.6	11.25	531	1.63	3.08
16	96	11.12	534	1.60	3.04
17	96.1	11.24	534	1.63	3.08
18	95.6	11.25	531	1.64	3.08
19	94.9	11.27	527	1.64	3.09
20	93.9	11.30	522	1.64	3.09

Table 8. Price impact of additional Florida orange juice production assuming new plantings are100 percent APS.

Year	Production	On-Tree Price	OJ Production	FOB	
				FCOJ price	NFC price
	mil. boxes	$/box	mil. SSE gal.	$/SSE gal.	$/SSE gal.
1	70	11.86	389	1.73	3.18
2	70.8	11.84	393	1.73	3.18
3	72.5	11.79	401	1.72	3.17
4	75.3	11.73	414	1.71	3.16
5	79.1	11.31	434	1.64	3.09
6	84.1	11.52	462	1.68	3.13
7	89.6	11.38	492	1.65	3.10
8	94.1	11.27	509	1.64	3.08
9	97.4	11.20	538	1.62	3.07
10	99.6	11.15	552	1.61	3.06
11	100.3	11.14	558	1.61	3.06
12	99.3	11.16	554	1.62	3.06
13	98	11.20	547	1.62	3.07
14	96.5	11.24	538	1.63	3.08
15	95.3	11.28	531	1.64	3.08
16	94	11.20	524	1.60	3.05
17	92.1	11.339	517	1.65	3.10
18	91.6	11.38	511	1.65	3.10
19	90.3	11.41	503	1.66	3.11
20	89.1	11.44	496	1.66	3.11

Table 9. Price impact of additional Florida orange juice production assuming 50 percent of new plantings are traditional and 50 percent of new plantings are APS.

Year	Production	On-Tree Price	OJ Production	FOB	
				FCOJ price	NFC price
	mil. boxes	$/box	mil. SSE gal.	$/SSE gal.	$/SSE gal.
1	70.0	11.86	389	1.73	3.18
2	70.4	11.85	391	1.73	3.18
3	71.9	11.82	397	1.73	3.17
4	74.1	11.76	408	1.72	3.17
5	77.1	11.37	424	1.65	3.10
6	80.9	11.60	445	1.69	3.14
7	85.1	11.50	468	1.67	3.12
8	89.0	11.40	481	1.66	3.11
9	91.9	11.34	508	1.65	3.09
10	94.0	11.28	521	1.64	3.08
11	95.3	11.25	529	1.63	3.08
12	95.7	11.24	532	1.63	3.08
13	95.7	11.24	533	1.63	3.08
14	95.5	11.25	532	1.63	3.08
15	95.4	11.26	531	1.63	3.08
16	95.1	11.16	529	1.60	3.05
17	94.4	11.29	526	1.64	3.09
18	93.6	11.31	521	1.64	3.09
19	92.6	11.34	515	1.65	3.10
20	91.5	11.36	509	1.65	3.10

Economic Impacts

Table 10 and Table 11 summarize the events as entered in IMPLAN© for each of the three scenarios. Due to increased production of fruit and juice in each scenario, there are significant economic impacts for the State of Florida regardless of the grove management strategy employed. Results of the economic impacts estimated for the increased fruit and juice production by the Florida citrus industry are summarized in Table 12 through Table 15. The total economic impacts are largest for the *APS* scenario, followed by the *50/50* scenario, and the *Traditional* scenario.

Table 10.Summary of IMPLAN© events associated with increased fruit production (Sector #4).

Year	Traditional		APS		50/50	
	Industry Sales	Employment (imputed)	Industry Sales	Employment (imputed)	Industry Sales	Employment (imputed)
	Event Year ($)	FT and PT Jobs	Event Year ($)	FT and PT Jobs	Event Year ($)	FT and PT Jobs
1	-	-	-	-	-	-
2	-	-	9,677,760	173	4,838,880	87
3	13,575,347	241	30,793,239	547	23,426,583	416
4	62,701,475	1,107	66,317,329	1,171	51,406,507	908
5	97,933,050	1,718	115,522,356	2,026	90,386,441	1,585
6	132,902,181	2,316	176,006,600	3,067	136,783,908	2,383
7	138,663,928	2,401	254,212,247	4,401	197,309,625	3,416
8	198,846,908	3,421	315,091,600	5,421	251,031,468	4,319
9	221,781,998	3,792	361,934,487	6,188	292,619,118	5,003
10	253,460,012	4,306	396,232,463	6,732	325,112,982	5,524
11	281,005,519	4,745	411,905,041	6,955	347,943,185	5,875
12	309,467,783	5,193	405,694,138	6,807	359,554,506	6,033
13	336,090,417	5,604	396,264,685	6,608	366,387,065	6,110
14	360,770,978	5,979	383,839,606	6,361	370,839,506	6,145
15	380,449,006	6,265	375,222,815	6,179	377,141,601	6,211
16	393,596,504	6,442	364,321,176	5,963	380,512,510	6,228
17	398,533,830	6,482	339,700,902	5,525	373,748,047	6,079
18	402,731,836	6,509	342,950,489	5,543	373,085,925	6,030
19	400,087,480	6,426	329,857,898	5,298	365,520,607	5,871
20	392,431,278	6,264	317,373,015	5,066	355,059,846	5,668

Note: For the purposes of adjusting for inflation, year 1 is assumed to be 2018.

Table 11. Summary of IMPLAN© events associated with increased juice production (Sector #79).

Year	Traditional		APS		50/50	
	Industry Sales	Employment (imputed)	Industry Sales	Employment (imputed)	Industry Sales	Employment (imputed)
	Event Year ($)	FT and PT Jobs	Event Year ($)	FT and PT Jobs	Event Year ($)	FT and PT Jobs
1	-	-	-	-	-	-
2	-	-	11,742,220	23	5,731,584	11
3	41,174,746	79	36,434,808	70	26,251,789	50
4	77,594,425	148	76,974,510	147	59,613,869	114
5	120,032,223	227	136,551,328	258	107,142,209	203
6	175,533,965	329	227,876,139	428	176,680,619	332
7	179,044,644	333	326,814,722	609	253,477,628	472
8	230,308,530	426	385,942,719	714	299,838,955	555
9	293,273,795	539	487,148,132	896	391,695,596	720
10	341,183,583	623	541,774,756	990	442,217,904	808
11	383,762,068	697	571,345,757	1,038	478,295,036	869
12	424,451,086	766	571,119,419	1,031	498,128,921	899
13	462,005,698	829	556,605,959	998	509,504,169	914
14	496,024,045	884	539,045,417	961	517,430,363	922
15	523,678,215	928	525,303,575	930	524,548,754	929
16	537,110,563	945	504,391,292	888	520,440,746	916
17	555,225,045	971	495,759,922	867	525,318,744	919
18	557,456,356	969	480,231,502	835	518,853,661	902
19	552,323,505	954	461,598,418	797	507,069,351	876
20	542,035,820	931	441,767,907	758	491,892,992	845

Note: For the purposes of adjusting for inflation, year 1 is assumed to be 2018

Table 12 displays the economic impact results for industry output (sales revenues) and value-added or gross state product (GSP) summed over the full 20-year period. Across the three scenarios, direct industry output impacts range from $10.34 billion (B) to $11.79 B including $4.40 B to $5.00 B to growers and $5.94 B to $6.79 B to juice processors. The direct industry output impacts yield total industry output impacts of $32.93 B to $37.55 B across all sectors of the economy. Direct value-added impacts are between $3.51 B and $4.00 B including $2.38 B TO $2.70 B for growers and $1.13 B to $1.30 B to juice processors. Total value-added impacts across all sectors are between $16.71 B and $19.04 B.

Table 12. Economic impacts associated with increased fruit and juice production over full 20-year time horizon, industry output and value-added.

Activity	Impact Type	Industry Output (Revenues - $Billions)			Value-added (GSP - $Billions)		
		Traditional	APS	50/50	Traditional	APS	50/50
Growers	Direct Effect	$4.40	$5.00	$4.66	$2.38	$2.70	$2.52
	Indirect Effect	$2.13	$2.42	$2.25	$1.24	$1.41	$1.31
	Induced Effect	$9.49	$10.79	$10.05	$5.66	$6.43	$5.99
	Total Effect	$16.02	$18.21	$16.97	$9.27	$10.54	$9.82
Juice processors	Direct Effect	$5.94	$6.79	$6.29	$1.13	$1.30	$1.20
	Indirect Effect	$3.46	$3.95	$3.66	$1.81	$2.07	$1.92
	Induced Effect	$7.52	$8.59	$7.95	$4.50	$5.14	$4.76
	Total Effect	$16.91	$19.34	$17.90	$7.44	$8.51	$7.87
TOTAL	Direct Effect	$10.34	$11.79	$10.95	$3.51	$4.00	$3.72
	Indirect Effect	$5.59	$6.37	$5.92	$3.05	$3.48	$3.23
	Induced Effect	$17.01	$19.38	$18.01	$10.15	$11.57	$10.75
	Total Effect	$32.93	$37.55	$34.87	$16.71	$19.04	$17.69

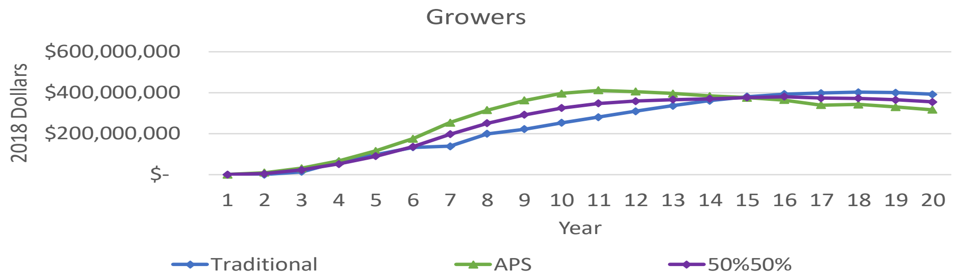
To put these results into perspective, annual averages have also been estimated, representing the average impact expected to take place for each year of the 20-year period, as shown in Table 13. The average annual direct industry output impacts range from $517 million (M) to $590 M including $220 M - $250 M to growers and $297 M to $340 M to juice processors. These direct industry output impacts yield annual average total industry output impacts of $1.647 B to $1.877 B across all sectors of the economy. The average annual direct value-added impacts are between $176 M and $200 M including $119 M - $135 M for growers and $57 M to $65 M to juice processors. Average annual total value-added impacts across all sectors are between $836 M and $952 M. Although the impacts are expected to be positive each year, the impacts reported in Table 13 are not expected to occur uniformly over the 20 years within the time period.

Table 13. Average annual economic impacts associated with increased fruit and juice production, industry output and value-added.

Activity	Impact Type	Industry Output (Revenues - $Billions)			Value-added (GSP - $Billions)		
		Traditional	APS	50/50	Traditional	APS	50/50
Growers	Direct Effect	$220	$250	$233	$119	$135	$126
	Indirect Effect	$106	$121	$113	$62	$70	$66
	Induced Effect	$475	$539	$503	$283	$321	$299
	Total Effect	$801	$910	$848	$464	$527	$491
Juice processors	Direct Effect	$297	$340	$314	$57	$65	$60
	Indirect Effect	$173	$198	$183	$90	$103	$96
	Induced Effect	$376	$430	$398	$225	$257	$238
	Total Effect	$846	$967	$895	$372	$425	$394
TOTAL	Direct Effect	$517	$590	$547	$176	$200	$186
	Indirect Effect	$279	$319	$296	$152	$174	$161
	Induced Effect	$850	$969	$900	$508	$578	$537
	Total Effect	$1,647	$1,877	$1,743	$836	$952	$885

Figure 4 displays the temporal distribution of the change in revenues observed for both growers and juice processors. Annual impacts are expected to follow these patterns for each of the three scenarios.

Figure 4. Temporal distribution of change in sales revenues.



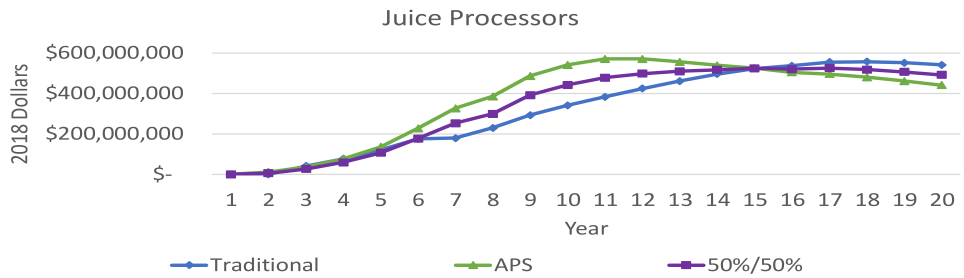


Table 14. Economic impacts associated with increased fruit and juice production over full 20-year time horizon, employment and labor income.

Activity	Impact Type	Employment (Job Years Supported)			Labor Income ($Billions) (Wages, Salaries, Benefits, Proprietor Income)		
		Traditional	APS	50/50	Traditional	APS	50/50
Growers	Direct Effect	79,211	90,032	83,890	$2.01	$2.28	$2.13
	Indirect Effect	24,624	27,988	26,079	$0.93	$1.06	$0.98
	Induced Effect	69,141	78,587	73,226	$3.30	$3.75	$3.49
	Total Effect	172,977	196,606	183,195	$6.24	$7.09	$6.61
Juice processors	Direct Effect	11,580	13,237	12,255	$0.81	$0.92	$0.85
	Indirect Effect	18,293	20,912	19,360	$1.09	$1.25	$1.16
	Induced Effect	54,933	62,799	58,137	$2.64	$3.02	$2.80
	Total Effect	84,806	96,948	89,752	$4.54	$5.19	$4.81
TOTAL	Direct Effect	90,790	103,269	96,145	$2.82	$3.21	$2.98
	Indirect Effect	42,917	48,900	45,439	$2.02	$2.31	$2.14
	Induced Effect	124,075	141,385	131,363	$5.94	$6.77	$6.29
	Total Effect	257,782	293,554	272,946	$10.78	$12.28	$11.41

Table 14 displays the economic impact results for employment (job years[8] supported) and labor income summed over the full 20-year period. Across the three scenarios, employment impacts range from just under 91,000 job years supported to over 103,000 job years supported, including 79,211 - 90,032 job years supported for growers and 11,580 - 13,237 job years supported for juice processors. The direct employment impacts yield total employment impacts of nearly 258,000 to over 293,000 job years supported across all sectors of the economy. Direct labor income impacts are between $2.82 B to $3.21B including $2.01 B to $2.28 B for growers and $0.81 B to $0.92 B to juice processors. Total labor income impacts across all sectors are between $10.78 B and $12.28 B.

[8] A job year is the equivalent of one job sustained for one year

Table 15. Average annual economic impacts associated with increased fruit and juice production, employment and labor income.

Activity	Impact Type	Employment (Job Years Supported)			Labor Income ($Billions) (Wages, Salaries, Benefits, Proprietor Income)		
		Traditional	APS	50/50	Traditional	APS	50/50
Growers	Direct Effect	3,961	4,502	4,195	$101	$114	$106
	Indirect Effect	1,231	1,399	1,304	$46	$53	$49
	Induced Effect	3,457	3,929	3,661	$165	$187	$175
	Total Effect	8,649	9,830	9,160	$312	$355	$330
Juice processors	Direct Effect	579	662	613	$40	$46	$43
	Indirect Effect	915	1,046	968	$55	$62	$58
	Induced Effect	2,747	3,140	2,907	$132	$151	$140
	Total Effect	4,240	4,847	4,488	$227	$260	$240
TOTAL	Direct Effect	4,540	5,163	4,807	$141	$160	$149
	Indirect Effect	2,146	2,445	2,272	$101	$115	$107
	Induced Effect	6,204	7,069	6,568	$297	$339	$315
	Total Effect	12,889	14,678	13,647	$539	$614	$571

Annual averages were also estimated for employment and labor income, as shown in Table 15. The average annual direct employment impacts range from 4,540 to 5,163 job years supported including 3,961 - 4,502 to growers and 579 - 662 to juice processors. These direct employment impacts yield annual average total employment impacts of 12,889 – 14,678 job years supported across all sectors of the economy. The average annual direct labor income impacts are between $141 M and $160 M including $101 M - $114 M for growers and $40 M to $46 M to juice processors. Average annual total labor income impacts across all sectors are between $539 M and $614 M. As previously noted, these impacts are not actually expected to be distributed uniformly over time.

Investment Costs

Estimated new grove establishment costs along with assumed per acre care-taking costs for traditional planting are shown in Table 16. Similar figures for an APS planting are shown in Table 17. APS requires higher initial investment costs compared to traditional planting. These higher costs stem from the purchase and planting of additional trees per acre and greater investment in irrigation because a dual system is employed.

Table 16.Estimated cost of new plantings disaggregated by region and variety, Traditional.

	Early and midseason oranges			
	Indian River	Northern & Central	Western	Southern
Density	145	145	145	145
		($)		
Tree Cost	8.5	8.5	8.5	8.5
Planting Cost	1.5	1.5	1.5	1.5
Land Prep	1,500	400	1,615	1,615
Irrigation[a]	1,500	1,500	1,500	1,500
Caretaking year 1	1,600	1,600	1,600	1,600
Caretaking year 2	1,700	1,700	1,700	1,700
Caretaking year 3	1,800	1,800	1,800	1,800
Caretaking year 4+	2,000	2,000	2,000	2,000
	‘Valencia’ oranges			
	Indian River	Northern & Central	Western	Southern
Density	145	145	145	145
		($)		
Tree Cost	8.50	8.50	8.50	8.50
Planting Cost	1.5	1.5	1.5	1.5
Land Prep	1,500	400	1,615	1,615
Irrigation[a]	1,500	1,500	1,500	1,500
Caretaking year 1	1,600	1,600	1,600	1,600
Caretaking year 2	1,700	1,700	1,700	1,700
Caretaking year 3	1,800	1,800	1,800	1,800
Caretaking year 4+	2,000	2,000	2,000	2,000

[a] Assumes land was previously planted in citrus and includes a well.

Table 17. Estimated cost of new plantings disaggregated by region and variety, APS.

	Early and midseason oranges			
	Indian River	Northern & Central	Western	Southern
Density	303	303	303	303
	($)	($)	($)	($)
Tree Cost	8.50	8.50	8.50	8.50
Planting Cost	1.50	1.50	1.50	1.50
Land Prep	1,500	400	1,615	1,615
Irrigation[a]	2,000	2,000	2,000	2,000
Caretaking year 1	2,100	2,100	2,100	2,100
Caretaking year 2	2,200	2,200	2,200	2,200
Caretaking year 3	2,250	2,250	2,250	2,250
Caretaking year 4+	2,250	2,250	2,250	2,250

	'Valencia' oranges			
	Indian River	Northern & Central	Western	Southern
Density	303	303	303	303
	($)	($)	($)	($)
Tree Cost	8.50	8.50	8.50	8.50
Planting Cost	1.50	1.50	1.50	1.50
Land Prep	1,500	400	1,615	1,615
Irrigation[a]	2,000	2,000	2,000	2,000
Caretaking year 1	2,100	2,100	2,100	2,100
Caretaking year 2	2,200	2,200	2,200	2,200
Caretaking year 3	2,250	2,250	2,250	2,250
Caretaking year 4+	2,250	2,250	2,250	2,250

[a] Assumes land was previously planted in citrus and includes a well.

In the North and Central regions, it is assumed that planting would not occur on beds, so a lower land prep charge was used. A figure of $8.50 per tree was assumed even those costs can vary due to scion/rootstock selected and source of new trees. Higher care-taking costs are assumed for APS groves. There is some disagreement among growers that this assumption is correct. There is an argument that the fertigation system utilized in APS may reduce fertilizer costs. APS groves planted at very high densities may require smaller versions of tractors and sprayers which would entail additional costs. Under the density assumed here, 303 trees per acre, existing equipment could easily be used. The estimated acreage planted and total investment cost for each scenario are displayed in Table 18.

Table 18. Estimated acres and total initial investment cost under three alternative planting scenarios.

		Traditional		Advanced Production Systems		50-50	
Year	New Trees	Acres	Cost ($mil)	Acres	Cost ($mil)	Acres	Cost ($mil)
1	3,000,000	20,690	$85.5	9,901	$61.9	15,295	$73.5
2	3,000,000	20,690	$85.5	9,901	$61.9	15,295	$73.5
3	3,000,000	20,690	$85.5	9,901	$61.9	15,295	$73.5
4	3,000,000	20,690	$85.5	9,901	$61.9	15,295	$73.5
5	3,000,000	20,690	$85.5	9,901	$61.9	15,295	$73.5
6	3,000,000	20,690	$85.5	9,901	$61.9	15,295	$73.5
Total	18,000,000	124,140	$ 513.0	59,406	$371.4	91,770	$441.0
		($4,134/ac)		($6,253/ac)		($4,820/ac)	

Although capital expenditures represent a cost to growers (or to programs that incentivize plantings), the investment also results in additional economic impacts for the State. The total economic impacts of the investment spending were also analyzed using the IMPLAN model© and the investment expenditure breakdowns, as shown in Table 16 and Table 17. Three industry sectors in IMPLAN© were used to analyze the investment expenditures: greenhouse, nursery, and floriculture production (sector #6), support activities for agriculture and forestry (sector #19), and construction of other new nonresidential structures (sector #58), which includes land preparation and the installation of irrigation systems. Tree costs were entered into sector #6, planting and caretaking costs were entered into sector #19, and costs associated with land prep and irrigation were entered into sector #58.

Table 19 on the following page summarizes the events as entered in IMPLAN© for each of the three scenarios.

Table 19. Summary of IMPLAN© events associated with investment.

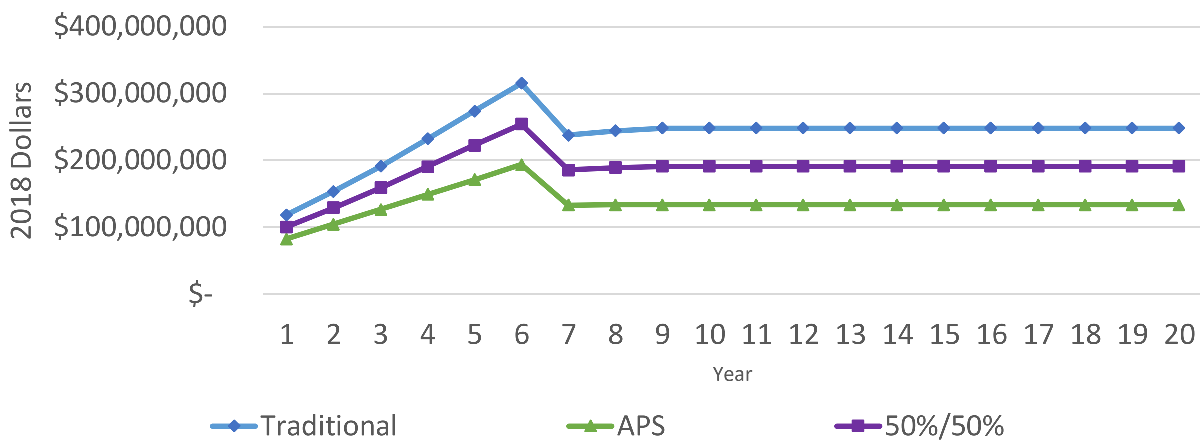
Year	Sector	Traditional		APS		50/50	
		Industry Sales (Event Year $)	Employment (imputed)	Industry Sales (Event Year $)	Employment (imputed)	Industry Sales (Event Year $)	Employment (imputed)
1	6	25,500,000	238	25,664,145	239	25,568,642	238
	19	37,604,000	834	25,318,967	561	31,460,163	697
	58	55,531,034	419	31,727,680	239	43,645,158	329
2	6	26,010,000	241	26,177,428	243	26,080,015	242
	19	74,232,540	1,633	48,040,946	1,057	61,136,519	1,345
	58	56,641,655	423	32,362,233	242	44,518,061	332
3	6	26,530,200	244	26,700,977	246	26,601,615	245
	19	114,463,768	2,499	72,176,675	1,576	93,321,163	2,038
	58	57,774,488	427	33,009,478	244	45,408,422	336
4	6	27,060,804	247	27,234,996	249	27,133,647	248
	19	160,665,830	3,482	97,258,617	2,108	128,964,377	2,795
	58	58,929,978	432	33,669,668	247	46,316,591	339
5	6	27,602,020	251	27,779,696	252	27,676,320	251
	19	208,670,189	4,488	123,314,966	2,652	165,995,992	3,570
	58	60,108,577	436	34,343,061	249	47,242,922	343
6	6	28,154,060	254	28,335,290	256	28,229,847	255
	19	258,530,457	5,518	150,374,665	3,209	204,457,286	4,364
	58	61,310,749	441	35,029,922	252	48,187,781	346
7	19	267,953,455	5,676	149,954,157	3,176	208,961,380	4,426
8	19	280,442,416	5,903	153,521,839	3,232	216,989,882	4,568
9	19	290,899,591	6,085	156,592,276	3,276	223,753,842	4,681
10	19	296,717,583	6,168	159,724,122	3,320	228,228,919	4,745
11	19	302,651,935	6,252	162,918,604	3,366	232,793,498	4,809
12	19	308,704,973	6,338	166,176,976	3,412	237,449,368	4,875
13	19	314,879,073	6,424	169,500,516	3,458	242,198,355	4,942
14	19	321,176,654	6,512	172,890,526	3,505	247,042,322	5,009
15	19	327,600,187	6,601	176,348,337	3,553	251,983,168	5,077
16	19	334,152,191	6,691	179,875,303	3,602	257,022,832	5,147
17	19	340,835,235	6,783	183,472,809	3,651	262,163,288	5,217
18	19	347,651,940	6,875	187,142,266	3,701	267,406,554	5,288
19	19	354,604,978	6,969	190,885,111	3,751	272,754,685	5,360
20	19	361,697,078	7,064	194,702,813	3,803	278,209,779	5,434

Table 20. Economic impacts associated with capital expenditures

Activity	Impact Type	Industry Output (Revenues - $Billions)			Value-added (GSP - $Billions)		
		Traditional	APS	50/50	Traditional	APS	50/50
Investment	Direct Effect	$5.41	$3.06	$4.23	$3.83	$2.15	$2.99
	Indirect Effect	$1.42	$0.81	$1.12	$0.66	$0.38	$0.52
	Induced Effect	$12.03	$6.79	$9.41	$7.17	$4.05	$5.61
	Total Effect	$18.86	$10.66	$14.76	$11.66	$6.58	$9.12

Table 20 displays the economic impacts associated with investment expenditures. The direct impacts are the total investment or the total costs to growers (or incentive programs) but the indirect and induced impacts are additional economic impacts that largely take place in other supporting industries in the State of Florida because of the investment expenditures for grove replanting. The sum of the indirect and induced impacts yield an economic impact of nearly $9 B in the *APS* scenario and over $13 B in the *Traditional* scenario in terms of industry output and over $4 B to nearly $8 B in terms of value-added, respectively, over the 20 year period. Note that investment costs, and as a result, the economic impacts are higher in the *Traditional* scenario because of the additional acreage planted and cared for. The expected temporal distribution of these impacts over time are shown in Figure 5.

Figure 5. Temporal distribution of capital expenditures.



Other Considerations

Alternative Management Strategies

The analysis only considered two alternative management strategies despite the success of alternative management strategies that vary by region and variety throughout the State. The APS scenario would require considerable resources where a modified management strategy would be more feasible for most citrus operations. The results of the study indicate that there are clear economic gains, both direct and indirect, resulting from increased replanting rates over the next decade.

Available Land

The availability of land to expand citrus production in Florida is not an issue for several reasons. First, the citrus canker eradication left tens of thousands of acres of vacant land, much of which has either neither been replanted nor converted to other use. Second, citrus eradication due to HLB has also left several thousand acres that had been previously planted to citrus and is currently vacant. Third, although peaches and blueberries have been touted as alternative crops to citrus in central and south Florida, planted area of these crops remain small relative to citrus.

Citrus Nursery Capacity

Replanting efforts are dependent on the capacity of the Florida nursery industry to meet demand for new plantings. In 1953, Florida launched the Citrus Budwood Registration Program to help ensure the selection of high quality trees that would yield quality fruit and maximize per acre yields. Another objective of the program is to protect commercial groves against the spread of pest and disease. The Citrus Budwood Technical Advisory Committee meets annually to discuss supply and demand of budwood and seed material (FDACS, 2016). There were 54 active nurseries in 2016 with more than 4.4 million propagations of orange, grapefruit, and specialty citrus varieties. Nearly 76 percent of these active nurseries each account for less than 100,000 propagations. There were approximately 3.95 million orange propagations over the last 5 years despite a fluctuation in the number of active nurseries. This study assumes that all propagated varieties are suitable for planting across all densities.

Continued existence of HLB

The Florida citrus industry, with the aid of state and federal assistance, has dedicated considerable resources into researching the mitigation of the impacts of HLB on the production of citrus; therefore, this study assumes that HLB will remain a production challenge for the foreseeable future with emerging mitigation measures that are incorporated into production practices each season.

Conclusions

This study provides a quantitative measure of the benefits associated with restoring Florida's commercial orange tree inventory under three scenarios in which new plantings occur across various densities. While commercial tree inventory is boosted at a higher rate with APS, the results indicate significant benefits across all replanting efforts.

The Florida citrus industry has endured many challenges in the past 15 years. These include the impact of citrus canker and the unsuccessful program to eradicate this disease. The hurricanes of 2004 and 2005 served to spread citrus canker throughout much of the commercial citrus production area. Even though HLB was not discovered until 2005, it was likely present in the state and was also spread by the hurricanes. A recent study by Singerman and Useche (2016) suggests that HLB is present in every block of commercial citrus in the state.

Given all the challenges faced by producers, incentive programs may be the key to increasing replanting efforts. Unlike many crops grown in the United States, the Florida citrus industry is subject to relatively few government programs that benefit growers. There is a tariff imposed on imported orange juice, but various trade agreements (North American Free Trade Agreement and the Caribbean Basin Initiative) have eliminated that tariff on all major import suppliers with the exception of Brazil. Florida growers also received disaster relief money after both the hurricanes of 2004 and are hopeful to receive relief from the losses associated with Hurricane Irma that scored a direct hit on the state's citrus industry in 2017. The industry also receives indirect support in the form of research efforts conducted both by the University of Florida and the United States Department of Agriculture-Agricultural Research Service (USDA-ARS) whose citrus research unit is located near Ft. Pierce, FL.

Given the economic toll that HLB has imposed on the Florida citrus industry since 2010, it is unlikely that funds to support expansion of the industry will be available from solely private sources. It is important to note that there have been efforts from both public and private entities to encourage new citrus tree planting in the state which is indicative of demand for locally sourced fruit. These programs are described and analyzed at the grove level in a recent paper by Spreen and Zansler (2016). As noted in that paper, the initial incentive program sponsored by a major citrus processor has been fully subscribed. Other programs sponsored by the Farm Service Agency (FSA) of the USDA and a second major citrus processor have also provided incentives for new citrus plantings.

Given the relative success of the major citrus processor program, it appears that direct cash incentives would stimulate the most interest among Florida growers. Two similar approaches are interest-free loans per tree planted and cost-sharing programs that provide cash assistance for a portion of the new investment.

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