CARIBBEAN FOOD CROPS SOCIETY

46

Forty Sixth
Annual Meeting 2010

Boca Chica, Dominican Republic
Vol. XLVI – Number 2
T-STAR Invasive Species Symposium

PROCEEDINGS
OF THE
46th ANNUAL MEETING

Caribbean Food Crops Society
46th Annual Meeting
July 11-17, 2010

Hotel Oasis Hamaca
Boca Chica, Dominican Republic

"Protected agriculture: a technological option for competitiveness of the Caribbean"

"Agricultura bajo ambiente protegido: una opción tecnológica para la competitividad en el Caribe"

"Agriculture sous ambiance protégée: une option technologique pour la compétitivité de las Caraïbe"

United States Department of Agriculture,
T-STAR Sponsored Invasive Species Symposium

Toward a Collective Safeguarding System for the Greater Caribbean Region:
Assessing Accomplishments since the first Symposium in Grenada (2003)
and Coping with Current Threats to the Region

Special Symposium Edition
Edited by
Edward A. Evans, Waldemar Klassen and Carlton G. Davis

Published by the Caribbean Food Crops Society

ISSN 95-07-0410

Copies of this publication may be received from:

Secretariat, CFCS
c/o University of the Virgin Islands
USVI Cooperative Extension Service
Route 02, Box 10,000
Kingshill, St. Croix
US Virgin Islands 00850

Or from

CFCS Treasurer
P.O. Box 506
Isabella, Puerto Rico 00663

Proceedings of the Caribbean Food Crops Society. 46(1): 170-179. 2010

THE ECONOMICS OF CITRUS GREENING DISEASE

Dr. Thomas H. Spreen, Professor, Food and Resource Economics Department, University of Florida, Gainesville, Florida

Citrus greening is a bacterial disease that affects all varieties of citrus trees. Its scientific name is *Huanglongbing* and therefore this disease is also referred to as HLB. The Chinese use the term "Yellow Dragon" since the disease attacks a tree, branch by branch, so that in its early stages, it looks somewhat like a small yellow dragon has crawled upon the tree as shown in Figure 1.

Citrus greening is spread by a small leaf-feeding insect known as the Asiatic citrus psyllid. Psyllids are an insect that could be tolerated if it did not serve as the vector of transmission for citrus greening. Psyllids prefer to feed on new growth, so that younger, more vigorous trees are more susceptible to infection, but any citrus tree can be infected.

Citrus greening affects an orange tree by attacking the phloem of the tree which disrupts the ability of the tree to uptake nutrients. Citrus greening may be confused with nutrient deficiency. It is believed that the disease moves through the tree, branch by branch, but once the tree is symptomatic, pruning will not eliminate the disease, but only give short-lived improvements in its appearance. Fruit produced on symptomatic branches are undersized, with low juice content. Furthermore, the juice is very bitter so that both the fruit and juice have no economic value (Figure 2). Citrus greening also promotes premature fruit drop and the canopy of the tree is also negatively affected. Once the tree is fully symptomatic, it is no longer of economic value.

At present, there is no cure for citrus greening nor do measures exist that mitigate its effects. Therefore, the recommended means of dealing with the disease is to use measures to suppress the population of psyllids and remove infected trees. Frequent scouting for the disease is recommended which increases the cost of grove maintenance. Increased use of both contact and systemic insecticides to control psyllid populations also increase grove maintenance costs. The primary limitation of this approach is that in mature trees, there is a period of latency between infection and expression of symptoms. Therefore, there is no guarantee that a policy of eradicating symptomatic trees will be successful in eliminating the disease.

A related economic issue is that in mature trees, even after a single branch exhibits symptoms, the remainder of the tree can produce useable fruit. Therefore, the grower is being asked to destroy an asset which can still produce positive economic returns over several more years, with no guarantee that such an action will prove to be effective in eliminating the disease. In Sao Paulo state, Brazil, laws have been enacted that require all citrus greening finds to be reported and immediate eradiation of symptomatic trees. There is evidence, however, that a significant proportion of growers are not following this regulation. No such law exists in Florida, and it is not known what percentage of growers is following an eradication policy.

World Citrus Markets

Citrus fruit is utilized in both fresh and processed form, with citrus juices being the most important processed product. In an economic analysis of citrus, it is important to distinguish between fresh and processed products.

The four major varietals of citrus are sweet oranges, grapefruit, mandarins (tangerines), and lemons. Limes are generally classified with lemons in citrus statistics although limes must be grown in frost-free climates while lemons are somewhat cold tolerant. Sweet oranges are the most important citrus variety in terms of production and value. According to USDA/FAS statistics, sweet oranges account for more than 65% of world citrus production. Mandarins are the second largest group accounting for approximately 25% of world production. While most citrus consumption is fresh, a significant proportion of the sweet orange crop is processed into orange juice. Orange juice is the most important fruit juice consumed in the world, and the value of orange juice trade exceeds US$3 billion annually (author's calculation).

In this paper, the economic impact of citrus greening is confined to an analysis of its possible effects on the world orange juice market. The interest of citrus greening and orange juice stems from the fact that the citrus industry in Sao Paulo (Brazil) and Florida (United States) have both experienced recent infection of citrus greening. Sao Paulo and Florida, combined, account for more than 80% of world orange juice production. Given the geographic concentration of world orange juice production, the impact of citrus greening on production prospects in Sao Paulo and Florida could have profound consequences on world orange production and prices.

One question that arises is that if orange juice production is severely curtailed in Sao Paulo and/or Florida, the resulting price increase should stimulate orange juice production elsewhere in the world. This observation, however, ignores both the time lag and large investment in infrastructure associated with the present industry. An orange tree planted today will not begin to produce fruit for three years, and reaches full production at 10–12 years of age. Therefore, rapid expansion of sweet orange production for juice in either an existing production region (e.g., Mexico) or a new production region would require at least a decade for significant new supply to be realized. Both Sao Paulo and Florida possess large investments in citrus processing plants, associated input supply industries, port facilities, juice storage, and other infrastructure investment that is not easily relocated to a new production region. Therefore, the presence of citrus greening in Sao Paulo and Florida raises the possibility of major disruption to the world orange juice market.

The World Orange Juice Market

The world orange juice market is dominated by two supply regions: Sao Paulo (Brazil) and Florida (United States). Collectively, these two regions account more than 80% of world orange juice production. Other suppliers include Mexico, Costa Rica, Belize, Cuba, Spain, Italy, Israel, Argentina, and Brazil. The largest supplier among this group is Mexico, whose production is approximately 380 million liters, which is less than 3% of the world supply.

The primary consumption regions are the European Union, the United States, and Canada. These three regions account for 80% of world consumption. Growing markets in Russia and China represent new opportunities for orange juice producers. World orange juice consumption, by country, is shown in Table 1.

Using a model developed at the University of Florida, projections of world orange juice production and consumption are developed under various assumptions related to the impact of citrus greening. Since citrus greening is present in both Sao Paulo and Florida, it is expected that citrus greening will have a substantial impact on world orange juice production and its price.

A schematic of the model is shown in Figure 3. The model begins with tree inventory, per tree fruit yield, and tree mortality rate for Sao Paulo and Florida. The tree inventory is interacted with the fruit yields to generate orange production in Sao Paulo and Florida. An adjustment is made for fresh utilization in each region and the remainder is converted into orange juice. Because of the importance of not-from-concentrate (NFC) orange juice in the United States and Canada, the model differentiates between NFC and from concentrate (FCOJ). A system of demand equations for the United States and Canada (both NFC and FCOJ) as well as the European Union and the rest of the world (FCOJ only) serves to allocate orange juice production from Sao Paulo and Florida across the four major consumption markets. Once price is determined in the consumption regions; deductions are used to account for transportation to consumption markets, the application of appropriate tariffs, and fruit processing to determine the delivered-in price in both Florida and Sao Paulo. The cost of harvest and haul to the processing plant in each region is also deducted to give what is known as the on-tree or net grower price. New planting equations have been estimated for Sao Paulo and Florida separately. New plantings in Sao Paulo are affected by the returns to sugarcane production as well as processed orange on-tree prices, while the Florida equation is a function of processed orange on-tree prices only. After new plantings are calculated, the tree inventory is aged one year and adjusted for tree mortality. Then next season production and prices are determined. The model is run over a finite time horizon in a forward recursive manner.

Specification of the Model

The orange juice demand equations and new tree planting equations are updated from those presented in Spreen et al. (2003). The 2010 Florida Commercial Citrus Tree Inventory is used as the initial tree inventory for Florida. The Sao Paulo tree inventory is based upon data obtained from confidential sources in Sao Paulo. The new tree planting equations for both Sao Paulo and Florida are of the same functional form as reported in Spreen et al. (2003) and updated using data through 2006. The 2009/10 season was used as the base year in order to validate the model.

In the model validation process, observed orange and orange juice production in both Sao Paulo and Florida, along with FOB, delivered-in, and on-tree prices, are compared to those generated by the model. Adjustments in those parameters such as the intercepts of the demand equations in the consumption markets are utilized so that predicted and actual endogenous variables values coincide.

Three scenarios are considered. These are the baseline, no greening, and high greening scenarios. In the no greening case, historical tree mortality rates are used. The baseline scenario assumes the presence of greening in both Sao Paulo and Florida, and that growers will follow a policy of eradicating positive trees. Thus, tree mortality rates are increased until the 2015/16 season at which point it is assumed that these rates level off. In the high greening scenario, tree mortality rates are raised to higher levels. This represents a more pessimistic scenario. Tree mortality rates by tree age for Sao Paulo and Florida across the three scenarios are shown in Figures 4 and 5, respectively. Note that in the no greening scenario, tree mortality rates in Sao Paulo are higher, compared to Florida. The is due to the widespread use of Rangpur Lime rootstock in Sao Paulo which is susceptible to blight (also known as decline). In the two scenarios that assume the presence of greening, tree mortality among the four- to eight-year tree age category has been increased proportionately greater. This is based upon consultation with horticultural and entomological experts who argue that since certain pesticides which are effective against psyllids are labeled for use on non-bearing trees, but because of limitations on

application rates per acre, are less effective once the tree reaches bearing age. These trees, however, are still quite vigorous and therefore are susceptible to the psyllids.

EMPRICAL RESULTS

Projected Florida orange production over the next 20 years under the three scenarios is shown in Figure 6. Projected orange production in Sao Paulo over the same time horizon is shown in Figure 7. On-tree (grower-level) prices in Florida are depicted in Figure 9. In baseline (with greening) scenario, Florida orange production is expected to decrease from its present level of 150–160 million boxes (6.1 to 6.1 million MT) to a range of 130–135 million boxes by the 2021/22 season and then stabilize thereafter (e.g., a box of oranges in Florida weighs 90 pounds and 1 metric ton equals 24.49 boxes). If greening were removed as a threat to the industry (no greening scenario), orange production is projected to increase from its present level throughout the forecast horizon reaching 180 million boxes by 2029/30. It is noteworthy that 180 million boxes is well-below the level of production achieved by Florida in the period preceding the hurricanes of 2004 and 2005. Under the high greening scenario, orange production is projected to decline sharply to a range of 100–110 million boxes by the 2021/22 season and then stabilize thereafter. Even under the relatively high tree mortality rates assumed under this scenario, the industry in Florida is projected to survive albeit at a much lower level of production.

Projected orange production in Sao Paulo is shown in Figure 7. The production paths of the three scenarios are similar to the forecasts for Florida. The production decline shown for the 2010/11 season is the current forecast for the orange crop in Sao Paulo. This decline is likely due to climate-related events, even though it is possible that effects of greening may be contributing factor. If so, the production forecasts presented are too optimistic and the effects of greening are being felt more quickly than what has been assumed in the model. Tree numbers as reported by the Foreign Agricultural Service of the United States Department of Agriculture (FAS/USDA) for Sao Paulo suggest that crops in the range of 330–340 million boxes represent the present production potential. In the baseline scenario, Sao Paulo orange production is projected to decline to slightly less than 300 million boxes by 2020/21, stabilize, and then gradually increase, recovering to present production levels by 2029/30. The projected production recovery is not related to an assumption that growers will find a solution for greening, but is due to the high prices expected for oranges and the fact that the Florida crop is expected to be constrained. In the no greening scenario, orange production is projected to gradually increase throughout the forecast horizon reaching a level in excess of 380 million boxes by 2029/2030. Similar to Florida, a crop of 380 million boxes is well-below the record crop of 424 million boxes established in the 1996/97 season. This result for both Sao Paulo and Florida is a consequence of recent shifts in the demand for orange juice in both the United States and Europe. The world orange juice market is smaller than it was five years ago, and hence the market limit on production in Sao Paulo and Florida has contracted. Under the high greening scenario, orange production in Sao Paulo is projected to decline to approximately 225 million boxes by 2020/21 and recover thereafter, exceeding 260 million boxes by the 2029/2030 season. Again, the projected recovery is due to the high prices that are expected.

On-tree prices for oranges produced in Florida over the forecast horizon are shown in Figure 8. Projected on-tree prices are in constant dollars and represent the net price received by growers. Presently growers receive approximately $6.00 per box, with early varieties (mostly Hamlin) receiving a lower price and Valenica oranges receiving a higher price. Under the baseline scenario, prices are expected to gradually rise reaching $8.00 per box by the end of the forecast horizon. Under present technology, this price level is well-above the cost of production.

Although the presence of greening increases both the cost of production as well as production risk, these results suggest that producers will be compensated at a sufficient high level which will induce them to remain in production. As was discussed elsewhere in this paper, grower prices at these levels could induce other production regions to enter the processed orange business. In the no greening scenario, prices are expected to remain relatively flat over the forecast horizon. This result suggests that $6.00 per box on-tree may be close to the long-run cost of production. Under the high greening scenario, prices rise sharply to nearly $10.00 per box.

CONCLUDING REMARKS

In this paper, the economic implications of citrus greening have been discussed. It was noted that it is imported to distinguish between fresh and processed citrus production although citrus greening has negative implications for both. Sao Paulo (Brazil) and Florida (United States) are the two dominant suppliers to the world orange juice market. A long-run production and price forecast for processed oranges was made using a model of the world orange juice market developed at the University of Florida. Three scenarios were analyzed: baseline (with greening), no greening, and high impact from greening. The results suggest that the processed orange industry in both Sao Paulo and Florida will survive even in the high greening scenario. The result will be substantially higher prices for oranges and, consequently, high consumer prices for orange juice. It was noted that higher grower prices might induce other production areas to enter the processed orange business, but this process will take many years as substantial investment in both citrus groves and processing plants would be required.

It is concluded that citrus greening represents one of the most profound events to confront the world citrus industry. The invention of frozen concentrated orange juice in the late 1940s provided the impetus for the development of the world processed orange industry. The freezes in Florida in the 1980s, expansion the industry in Sao Paulo, and more recently the shift to not-from-concentrate (NFC) orange juice have been other major events that helped shape the industry of today. The analysis presented herein suggests that citrus greening represents a challenge of a similar magnitude.

REFERENCES

Citrus Research and Education Center, University of Florida, Lake Alfred, FL website. http://www.crec.ifas.ufl.edu/extension/greening/index.htm.

FAS/USDA. 2010. *Brazil — Citrus Semi-annual, 2010*. GAIN Report No. BR10005, Foreign Agricultural Service, United States Department of Agriculture, Washington, D.C.

Spreen, T., C. Brewster, and M. Brown. 2003. The Free Trade Area of the Americas and the world processed orange market. *Journal of Agricultural and Applied Economics* 35: 107-126.

Table 1. World Orange Juice Consumption

Season	U.S.	EU	Canada	Russia	Japan	South Korea	China	Australia	Others	TOTAL
	- million SSE gallons -									
2000-01	1,482	1,390	165	16	155	66	17	64	123	3,477
2001-02	1,460	1,426	164	37	135	69	48	68	108	3,515
2002-03	1,433	1,513	157	52	135	78	57	64	119	3,608
2003-04	1,465	1,663	155	63	127	67	67	68	137	3,812
2004-05	1,394	1,543	150	64	127	64	63	68	139	3,613
2005-06	1,340	1,415	161	78	128	65	74	58	120	3,439
2006-07	1,258	1,177	123	78	125	58	87	58	143	3,107
2007-08	1,166	1,224	187	84	106	54	88	56	120	3,085
2008-09	1,214	1,341	150	61	99	42	84	54	119	3,164
2009-10	1,226	1,288	135	56	91	49	82	58	123	3,108

Source: FAS/USDA; FDOC

Figure 1. HLB-infected tree.
Source: Citrus Research and Education Center, University of Florida, Lake Alfred, FL

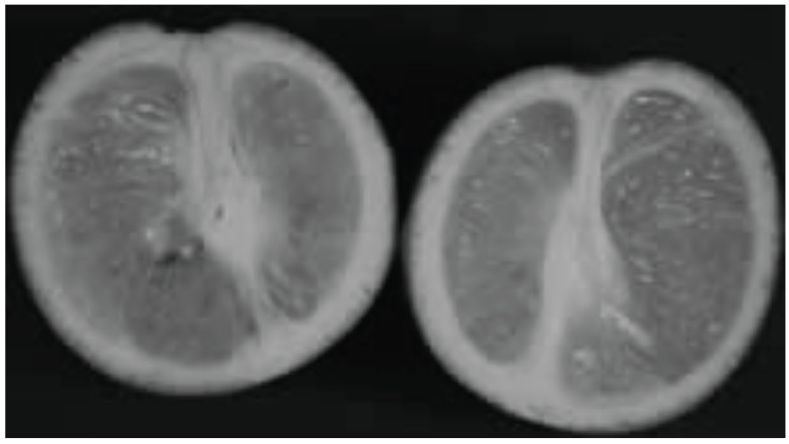

Figure 2. Examples of HLB-infected fruit.
Source: Citrus Research and Education Center, University of Florida, Lake Alfred, FL

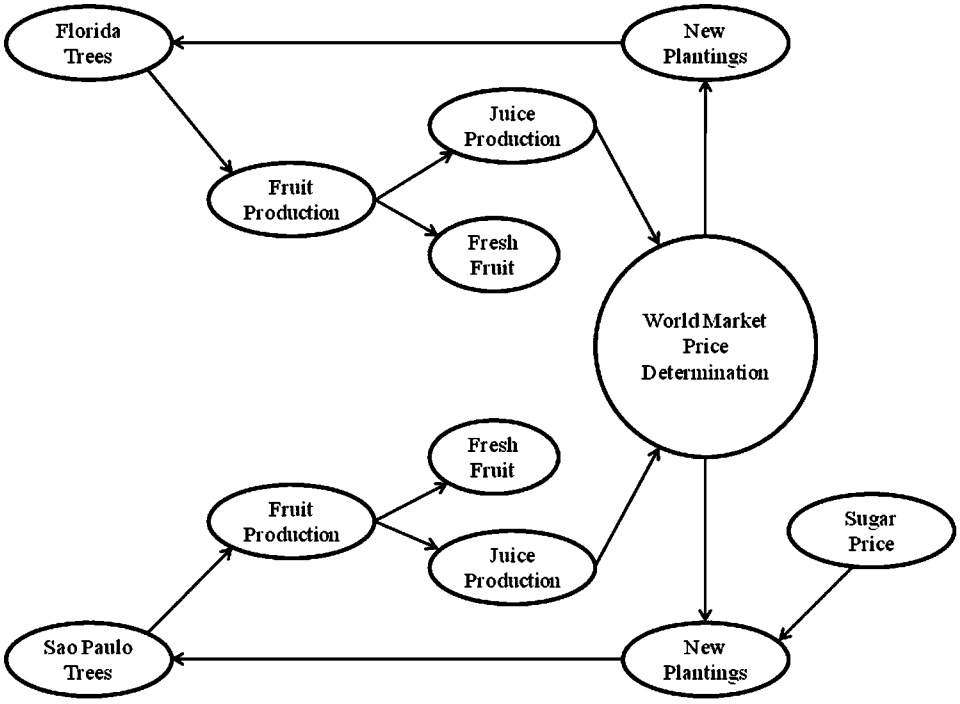

Figure 3. Flow chart of the world orange juice model.

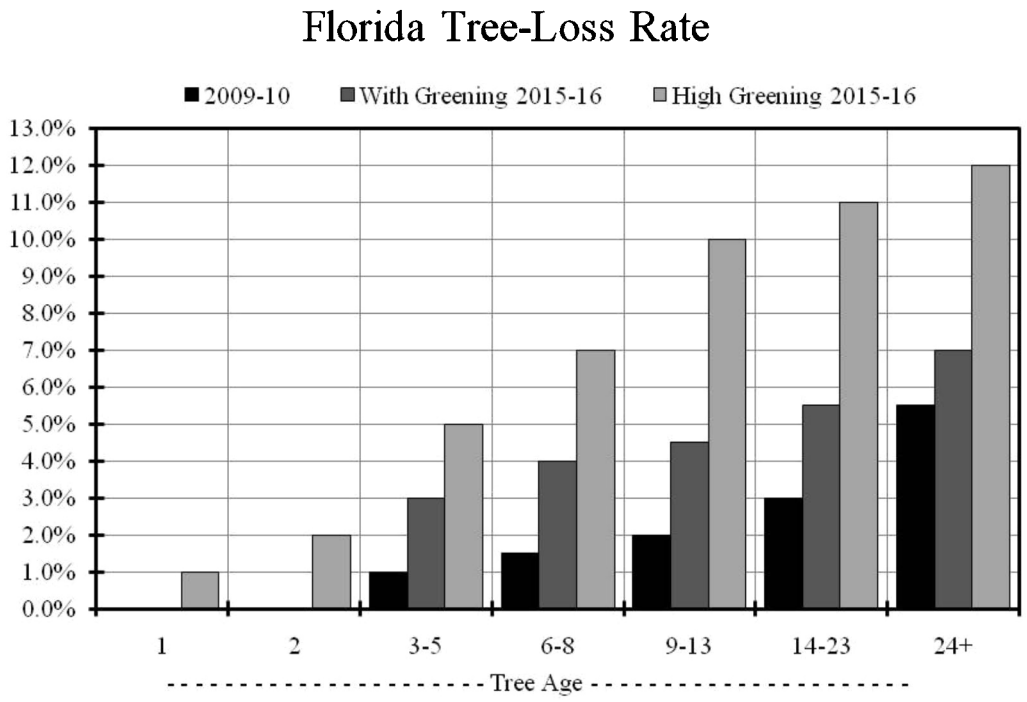

Figure 4. Tree mortality rates in Florida under three different greening scenarios.

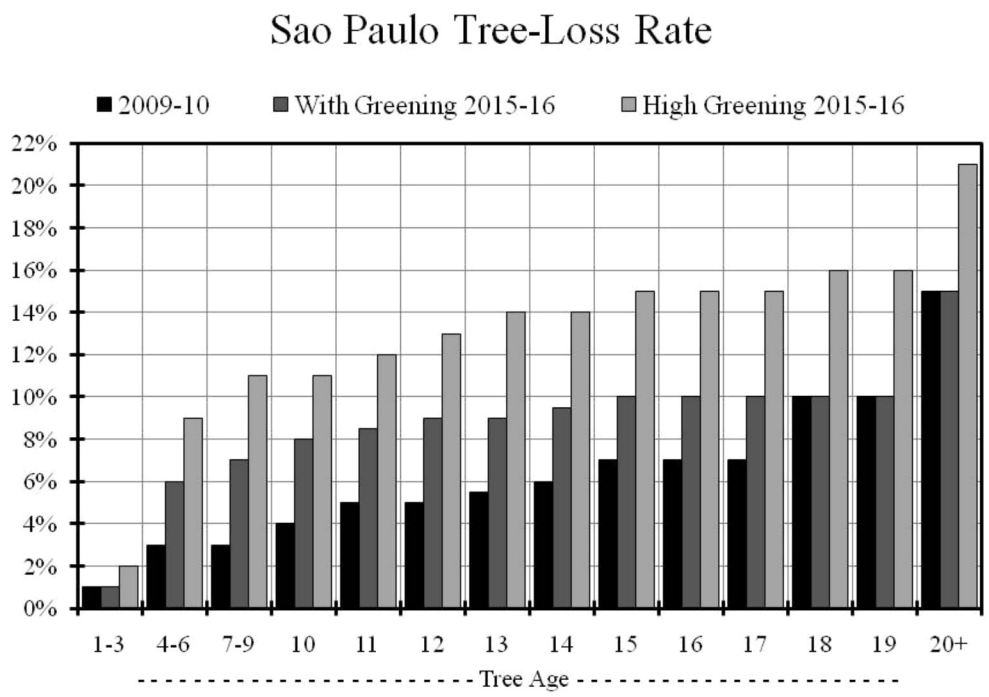

Figure 5. Tree mortality rates in Sao Paulo under three different greening scenarios.

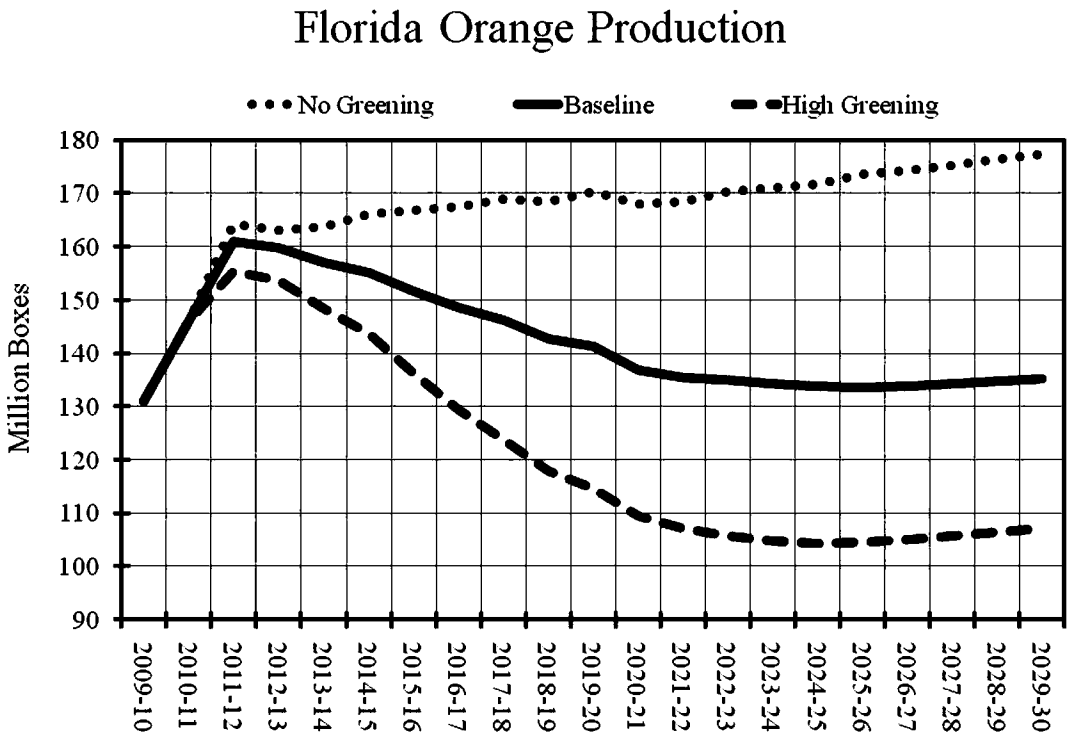

Figure 6. Projected orange production in Florida under three different greening scenarios.

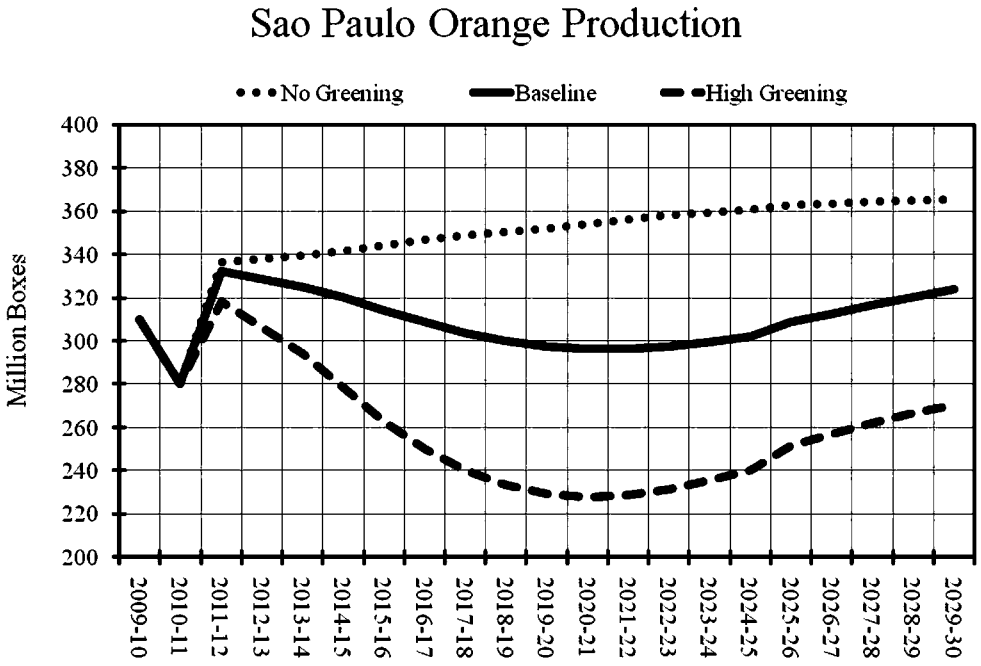

Figure 7. Projected orange production in Sao Paulo under three different greening scenarios.

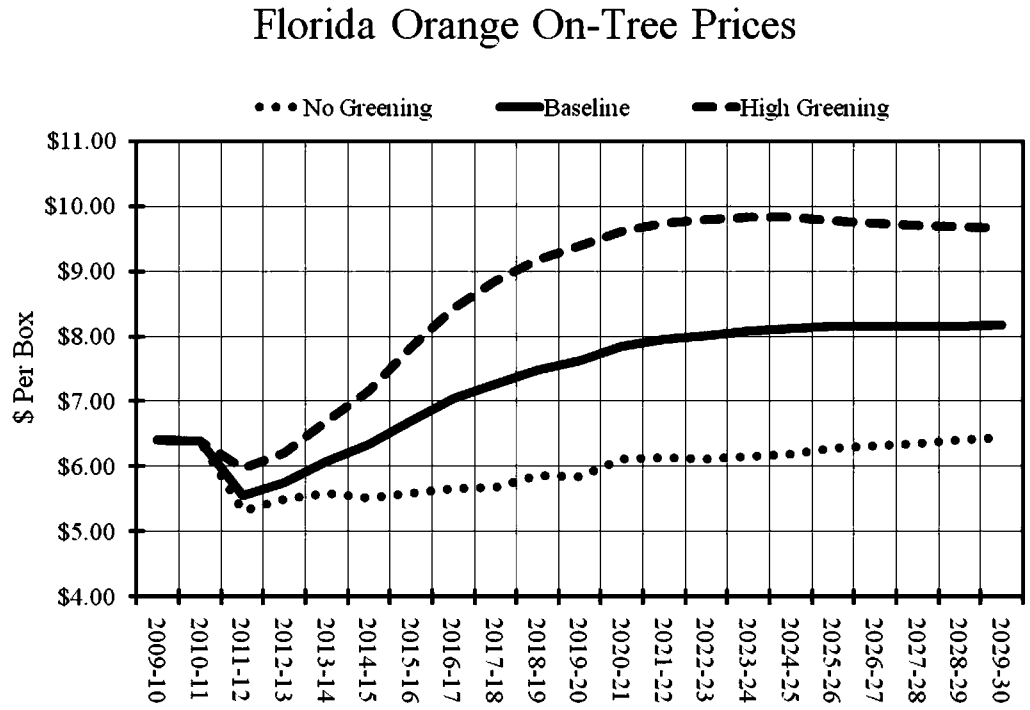

Figure 8. Projected processed on-tree prices in Florida under three different greening scenarios.