Is Growing Oranges in Florida a Good Investment?

Carlos J. O. Trejo-Pech
Assistant Professor, Agricultural and Resource Economics Department, University of Tennessee at Knoxville, TN.
And
Adjunct Professor, Universidad Panamericana. Escuela de Ciencias Económicas y Empresariales. Zapopan, Jalisco, México.
ctrejope@utk.edu

Thomas H. Spreen
Professor Emeritus, Food and Resource Economics Department, University of Florida, Gainesville, FL.
tspreen@ufl.edu

Marisa L. Zansler
Director, Economic and Marketing Research, Florida Department of Citrus, Gainesville, FL.
mzansler@ufl.edu

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Abstract

We provide a financial model to evaluate an orange grove investment in Florida, the producing region supplying around 90% of U.S. domestic production of orange juice. A representative orange grower planting early-mid varieties for the processed market is featured in the case. The study assumes that an existing grove has been disease-infested to a degree that there is little, if any economic value in maintaining it. The grower is left with the choice to replant the grove or to convert the land to other uses. The replanting baseline model yields a 9.5% Modified Internal Rate of Return (MIRR) and the Monte Carlo simulation shows that MIRR is equal or higher than the 7.5% hurdle rate around 79% times the model is simulated. The risk of managing an orange grove is higher than a decade ago mainly due to the presence of huanglongbing (HLB), a disease that reduces yields and degrades fruit quality, causing variability in productivity and operating costs. Opportunities include new guidelines for packaged foods labels, becoming effective in 2018, which may increase the demand of orange juice. In addition, growers may benefit from planting incentive programs implemented by both the government and major citrus processors and from policy changes such as the possibility of changes in depreciation of new investment for income tax purposes. Readers of this case study are expected to challenge the assumptions of the financial model and consider additional elements of risk and opportunities on their assessment of the potential orange grove investment.

Keywords: Agribusiness finance, Capital budgeting, Investment valuation, Simulation, Orange, Citrus greening.

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By 2017, after several years of declining supply of oranges and high prices, replanting a grove with significant or total devastation by diseases could represent an opportunity for growers in Florida to meet the demand for processed oranges. The State of Florida supplies around 90% of U.S. domestic production of orange juice. The risk of managing an orange grove, however, is higher than a decade ago mainly due to the presence of huanglongbing (HLB, also known as citrus greening), a disease that reduces yields and degrades fruit quality. This case study provides a capital budgeting model to evaluate a potential orange grove investment.

Due mainly to HLB, orange production in the State of Florida has decreased every year since the 2011-12 crop season. Total orange production in the 2015-16 season,[1] at 81.7 million 90-pound boxes, was approximately one-third of production relative to the 2003-04 season, prior to HLB. Research efforts to mitigate the negative effects of HLB are underway on several fronts, but the disease is still a real threat for this industry.[2] Furthermore, according to the Commercial Citrus Tree Inventory by the USDA's National Agricultural Statistics Service (NASS), new plantings have been less than tree removals over the past ten seasons, leading to a slow decline in the bearing tree inventory. The economic impact of HLB was estimated to be $4.393 billion over the period 2012-13 to 2015-16, causing the loss of at least 7,945 jobs (Court et al. 2017). Similarly, Farnsworth et al. (2014) estimated the impact of HLB slightly over $1 billion during the 2012-13 season. The challenge for both public and private entities has been, in recent years, to develop programs that incentivize new tree planting despite the production risks posed by HLB. Efforts to better understand the financials behind a grove investment, such as this study, may help decision makers in this industry.

We next describe a typical orange grove investment and present results for a baseline model. This is followed by a description of risks and opportunities. HLB constitutes the main source of risk, causing variability in productivity and operating costs. Opportunities include new guidelines for packaged foods labels, becoming effective in 2018, which may increase the demand of 100% orange juice by providing the consumer with more information on the nutritional content of 100% juices. In addition, growers may benefit from planting incentive programs implemented by both the government and major citrus processors and from policy changes such as the possibility of changes in depreciation of new investment for income tax purposes. Recent improvements in citriculture practices may also benefit orange producers. A concluding remarks section ends this study. Readers of the case are expected to challenge the assumptions of the model and consider additional elements of risk and opportunities on their assessment of the potential orange grove investment.

Assumptions for a grove investment model

This study assumes that a grove is HLB-infested to a degree that there is little, if any economic value in maintaining it. The grower is left with the choice to replant the grove or to convert the land to other uses. Replanting implies: a) invest capital to reestablish the grove (establishment), b) maintain the young trees until they become productive at about three to four years old (early caretaking), c) perform cultural activities to keep the grove productive (caretaking and reset), d) harvest and transport the fruit to the processing facility (harvest and haul), and e) sell the fruit (selling). Citriculture practices and cost structures presented in this case do not apply to every grower or situation, but are representative of a typical, medium-size grove. Practices and costs are based on research experiments or surveys to growers and suppliers conducted by personnel from the University of Florida's Institute of Food and Agricultural Sciences (UF-IFAS), an institution

covering extension and research efforts on the citrus industry. The case focuses on a grower planting early-mid varieties for the processed market in Southwest Florida.[3]

Establishment and early caretaking

Reestablishing a grove begins with the removal of existing trees and cleanup of the area.[4] Land preparation follows tree removal. The acquisition and installation of an irrigation system is also part of the initial investment. Planting cost involves both the cost per tree and number of trees to plant and the cost of planting,[5] staking and watering the young trees. Table 1 provides investment per acre at "Year 0", replanting time, assuming a planting density of 225 trees per acre. Planting density is a relevant decision for a grove investment as will be discussed later in this study. Most existing groves in Florida are planted at 145-150 trees per acre while some new plantings are at 220-225 trees. Densities equal or higher than 300 trees qualify as Advanced Production System (APS). APS is an experiment started in 2009 by a research team at UF-IFAS envisioned to help the industry to survive HLB and remain competitive by testing innovative horticulture practices. APS not only involves higher densities, is a technology that included a switch away from micro sprinkler to computer controlled drip irrigation which also includes fertigation through the irrigation system. This is an important feature of APS which promotes early maturation of the young trees, meaning more fruit early in tree life thus reducing the payback period of an investment. A detailed explanation of APS is provided in the "horticultural practices and planting density" section.

Early caretaking activities, including weed control, foliar spray, fertilizer application, sprouting, and irrigation, are conducted during the first 3 years while trees are young and unproductive (table 1). Supervision, overhead, and disease related effort costs are part of maintaining a grove. An example of disease-related efforts is the Citrus Health Management Areas

(CHMA) program, which coordinates neighboring citrus growers to work together to combat the Asian citrus psyllid, the vector that spreads HLB. While some early caretaking activities may occur immediately after planting, it is assumed that all costs accrue by the end of the year, as is standard in capital budgeting. At the end of 2016, under Internal Revenue Service (IRS) rules total establishment and early caretaking costs are depreciated using a 10-year straight-line depreciation schedule, with the first depreciation expense reported in the income statement only when the grove becomes productive, generally in the fourth year after planting.

Caretaking

The cost of cultural activities significantly increases when trees become productive. The Citrus Research and Education Center (CREC) at IFAS-UF surveys growers and suppliers every season. Table 2 provides caretaking costs from these surveys for a typical irrigated, productive grove in Southwest Florida during the last two crop seasons and during 2005-06, prior to HLB. Total caretaking costs (without reset and indirect costs) were $774 per acre prior to HLB ($920 in 2016 CPI adjusted dollars). Caretaking costs increased to $1,199 per acre ($1,387 in 2016 dollars) with the arrival of HLB during 2006-07, and are $1,651 and $1,525 during 2014-15 and 2015-16 respectively.

Foliar spray that also includes application of insecticides and fungicides is applied for disease and pest management purposes. With HLB, "enhanced" foliar sprays that include both macro and micro nutrients are used to improve the health of trees and with the intent to mitigate the effect of the disease though the application of nutrients via the leaves. As a consequence, foliar spray cost is the item among all caretaking activities that increased the most as the incidence of HLB spread. Fertilizer program cost experienced the second highest growth as growers incorporated micro nutrients such as calcium to mitigate the effects of HLB (Muraro 2012). Foliar

spray and fertilizer together represented around 70% of caretaking costs in the two most recent seasons. Furthermore, these costs vary significantly among growers, as groves may face HLB severity differently. Singerman (2015) reports the volatility of those costs across respondents: standard deviation for foliar spray is $199 and $333 for fertilizer program. Other costs, in table 2, have remained similar over the years.

Reset

Once the replant decision is made, the grower may replace diseased, damaged or unproductive trees in the reestablished grove to keep the level of trees at the original planting density; practice known as reset. Resetting is more critical during epidemic diseases because it contributes to suppression of the vector of the disease by partially cleaning the grove on a continuous basis. The trade-off is the cost of this activity, the time lag between planting time and production, and the higher susceptibility of young trees to HLB. Currently, the common practice in Southwest Florida is to reset. A study prior to HLB demonstrates that resetting was more profitable for a grove diseased by the citrus tristeza virus (Muraro, Roka, and Stansly 1999) compared to other alternatives such as doing nothing and continue cultivating for several years before deciding to replant the entire grove. Table 2 provides resetting costs. During 2015-16, resetting costs $42.90 per tree. Tree removal, site preparation, and planting (including trees) cost $17.50 while supplemental caretaking for years 1 through 3, the unproductive life, cost $25.40, or $8.46 ($25.40/3) per tree / year. Growers reset, on average, 9 trees per acre, which implies a tree loss rate in the range of 4% to 6% for planting densities from 150 to 225 plants per acre. Morris, Muraro, and Castle (2011) state that loss rates can be kept low by employing the standard HLB management protocol from the start at replanting time rather than later when infection rates could

get out of control. They estimate 5% loss rate for a replanted grove, 2% due to HLB and 3% due to other causes.

Harvesting and Hauling

Early-mid varieties of oranges in Florida are typically harvested between late November and February. Oranges are mostly hand-picked, with only a small portion of total acreage harvested mechanically. Picked fruits are placed in field bins and then loaded into trailers. Fruits in trailers are then transported to the processing plant. Table 3 provides harvesting and hauling costs for selected seasons. During 2015-16, average harvesting cost increased 23% relative to the previous season, from $1.990 to $2.440 per box. Singerman, Burani-Arouca, and Futch (2016) suggest this jump is partially due to a more severe HLB attack, which causes trees to produce smaller fruits, reducing harvesting efficiency. (Labor cost has also increased as growers rely on foreign workers, and harvesting under HLB has become more arduous.) The correlation between tree productivity and harvesting cost is negative. The eventual mitigation of the effects of HLB and consequently increase of productivity may reduce harvesting costs. Mechanical harvesting would likely also decrease costs. However, mechanical harvesting is less likely in the mid-term while HLB prevails in the region (Moseley, House, and Roka 2012). Table 3 also provides hauling costs according to the distance between the grove and the processing plant.

Prices and Yields

Prices and yields constitute a major source of uncertainty for the grower. Oranges are intentionally produced either for juice processing or for fresh consumption (generally, costs are higher to produce for the fresh market). According to the Florida Department of Citrus (FDOC), approximately 96% of Florida orange production is currently utilized for juice processing. Some growers enter into fixed-price contracts with processors, but many orange producers in Florida

participate in a pool, meaning that they receive the average price of the pool of producers. Table 4 provides weekly prices paid to pooled growers during the 2014-15 and 2015-16 seasons in dollars per pound solids for early-mid varieties in Florida.

Yields are determined by climate, management practices, and to a great extent by the degree of HLB infestation in a grove. HLB degrades the fruit reducing both quantity and quality, expressed in number of boxes per tree and total pounds solids per box (juice yield) respectively. Staff from the Florida Department of Agriculture and Consumer Services (FDACS) measure the juice content of per fruit delivered to processors. Average yields are made public by the State on a weekly basis through the harvesting season. Table 4 provides pooled grower averages of pounds solids per box during the two most recent seasons.

Yields also depend upon the age of trees. Table 5 provides production per tree estimation by the Florida Agricultural Statistics Service, USDA-FASS, during the last two seasons. Fruit and juice yield estimates are based on surveys conducted by this agency between August and harvest and using the number of bearing trees in the Commercial Citrus Inventory. Since estimates are according to field surveys, yields in table 5 are presumably tilted towards groves managed under conventional horticulture practices and infected by HLB. Singerman and Useche (2016) surveyed growers covering around 30% of total citrus acreage in Florida, and found that 57% reported that at least one tree in every single acre of their groves was HLB-infected and fruit yields have been reduced about 40% due to the effects of HLB.

Baseline model results

We put together assumptions from the previous section in a capital budgeting model. Table 6 gives projected free cash flows (*FCF*s) for the grove investment in dollars per acre.[6] Initial investment is from table 1. Irrigation cost in table 1 is estimated in $1,093 per acre for a new

grove. When reestablishing the grove, a grower can reuse part of the irrigation infrastructure, but the pipes and emitters would have been destroyed and would need replacement, this is estimated to cost $400 per acre as in Spreen and Zansler (2016). Revenues depend upon volume (number of productive trees; number of boxes per tree, table 5; and the mean of weekly juice yields, table 4) and price (mean of weekly prices, table 4). The number of productive trees for any given year depends on the mortality rate. This baseline model assumes a flat 5% tree loss rate, as discussed previously for a grove following standard HLB management protocol. This assumes that every year 5% of the total trees die and are replaced by resetting. Considering a 225 planting density, after the end of the first year around 11 trees are replaced (figures rounded), leaving 214 one year old trees and 11 recently planted. By the fourth year, when the grove becomes productive, only 183 are 4 years old (183.3, in table 6), with small groups of three-, two-, one-year old and recent planted trees. Since the mortality rate and density planting are kept constant over time, beginning year 4 we have the same number of productive trees every single year. Operating (caretaking, resetting, harvesting and hauling) and indirect costs are the average of the two most recent seasons. We assume an average of 50 miles as the distance from the grove to the processor.

Resetting increases costs and potentially reduces total volume as some infested trees that might continue producing are replaced with unproductive young trees. Resetting is advisable though since it increases the life expectancy of the grove. For valuation purposes, resetting gives a "perpetual" life to a citrus grove (Singerman, Burani-Arouca, Futch 2016; Morris, Muraro, and Castle 2011). When valuing a project on perpetuity it is customary to project free cash flows over a foreseeable horizon (up to year T), and then estimate a terminal value that reflects the present value of all *FCFs* occurring thereafter (PV_T). A common and convenient approach to estimate the terminal value is to use the constant growth model, which assumes that the *FCFs* grow at a constant

growth rate, *g*, beyond *T,* known as the steady-stage period. Terminal value (in present value terms, PV_T) is estimated by applying the equation: $PV_T = FCF_{T+1} / (CC\text{-}g)$, where *CC* is the opportunity cost of capital (this equation is the reduced form of an infinite series of *FCFs* growing at *g*, and discounted at CC; refer to Schill 2013).

Terminal value is usually a large component in a valuation, so sensitivity analysis is recommended. In order for the constant-growth model to be applicable to citrus production, the project is expected to enter a steady stage in the terminal year, implying that all transitional effects are over. This baseline assumes that *T* is year 15 based on the fact that the investment cost is fully depreciated by then, operating income is stable (table 6) and the grove is already mature (yields have reached a stable level that year). Furthermore, HLB, a major transitional effect, should be under control by then. We assume 0% growth rate, *g*, after year 15. The opportunity cost of capital is assumed to be 7.5%. The cost of capital in previous studies for citrus varies between 5% to 10% (Spreen and Zansler 2016; Muraro, Roka, and Stansly 1999). *FCFs* for the baseline model are in table 6. The Modified Internal Rate of Return (MIRR)[7] is 9.5% and the Net Present Value (NPV) is $2,177 per acre.[8]

Scenario analysis and simulation

The previous result is only a point-estimate of the baseline model. Grove care varies across regions and block such that inputs differ from our assumptions based on various factors. Scenario analysis or "What If" analysis, on which selected assumptions are expected to move within reasonable ranges, is advisable for capital budgeting evaluation. Graham and Campbell (2001), by surveying Chief Financial Officers in the United States, report that around 52% of companies use scenario analysis as one of their tools when evaluating investment projects. As one of the purposes of this study is to feature a case for teaching purposes, we do not provide scenario analysis results.

Students are expected to perform this analysis by incorporating different elements of risks and opportunities in the sector (description below). The baseline model result could be considered as a "most likely" scenario, on which the level of HLB severity continues as it is, in the near future. Scenarios on which HLB improves and worsens could be considered. Scenario analysis results could be contrasted and complemented with simulation results.

Simulation can be performed to incorporate simultaneous changes in assumptions that, presumably, follow a determined statistical distribution. Figure 1 provides an example of Monte Carlo simulation with the assumptions described next. Students are expected to challenge and discuss these assumptions. Juice quality (e.g., pounds solids per box) and prices are assumed to follow a normal distribution with a mean and standard deviation according to data of the two most recent seasons. Similarly, spray and fertilizer costs, which together account for 70% of caretaking costs, follow a normal distribution. Tree loss rate is assumed to vary uniformly between 2% and 6%. Harvesting cost vary uniformly with minimum and maximum values during the last two seasons, in table 3. Finally, expedited depreciation (more below) has 50% chance to be approved for use in citrus. Figure 1 shows the distribution of MIRRs when 1,000 simulations are run. MIRR is equal or higher than the hurdle rate of 7.5%, around 79% times the model is simulated.

Risk and opportunities

The quantitative analysis could be complemented by incorporating elements of risks and opportunities in citrus, featured in this section.

HLB

In Florida, HLB is caused by the bacterium *Candidatus* Liberibacter asiaticus, transmitted by *Diaphorina citri*, an insect known as the Asiatic citrus psyllid (the vector, hereafter).[9] Vectors retain the pathogen for life following 15 to 30 minutes access feeding on a diseased plant, and

transmit it to other plants after feeding for as little as 15 minutes (low likelihood of transmission) or for one hour or more (Mead and Fasulo 2014). The bacterium causes root dysfunction, and infected oranges generally present an irregular pattern of leaf chlorosis and scattered spots of green. Effects of HLB on productivity include fruit drop, fruit deformation, poor juice quality, and general tree decline (Tansey et al. 2017; Mead and Fasulo 2014). Detected in Florida in 2005, HLB has been referred to as the most destructive disease of citrus known (Gottwald et al. 2012).

Over the course of more than a decade, growers have tried different strategies to contain HLB and gained some experience on dealing with the disease. To reduce HLB spread, early strategies included aggressive scouting for the disease and removal of HLB symptomatic trees. This practice, however, is costly when a large number of trees are infected (Tansey et al. 2017) and nearly all growers do not remove HLB-symptomatic trees (Singerman and Burani-Arouca 2012). Aggressive control of the vector and area-wide insecticide spray management programs can be cost effective even when HLB incidence is high (Tansey et al. 2017). Although control of the vector is a short-term solution while a cure is found (Grafton-Cardwell, Stelinski and Stansly 2013), it is likely the most important strategy growers have to delay and reduce the effects of HLB (Tansey et al. 2017). Citrus Health Management Areas (CHMAs), started in 2010 and coordinated by UF-IFAS Extension and FDACS, is a program to fight the vector over a wide geographical area. In addition, foliar nutrition spray programs[10] may reduce trees stress caused by the infection and help tree productivity by allowing foliage to acquire nutrients that are otherwise limited by the root dysfunction caused by the bacterium (Tansey et al. 2017). Both foliar nutrition sprays and vector control are currently common practices in Florida helping growers to contain HLB, but have significantly increased production costs, as shown in table 2.[11] Some studies have casted doubt, however, on whether costs of these practices *individually* implemented offset the benefits (Tansey

et al. 2017; Gottwald et al. 2012), and propose more integrated practices (Gottwald et al. 2012) such as foliar sprays, area-wide vector management plus removal of HLB symptomatic trees.

Horticultural practices and planting density

In 2009, a research team at UF-IFAS began APS, an experiment envisioned to help the industry to survive HLB and remain competitive until a long-term solution is available (Schumann, Syvertsen, and Morgan 2009).[12] A block of trees cultivated under standard growing practices (e.g., granular fertilizer and micro sprinkler irrigation) was compared to blocks with non-standard practices including drip fertigation, open hydroponics, alternative rootstocks, and high plant densities. Schumann et al. (2012) reported the progress of the research when 3-year-old trees were harvested. The integration of non-standard practices, APS, produced early high fruit yields. That is, the normalized production level of the 3-year-old trees is equivalent to what would not have been achieved until year 5 under conventional practices. High planting density was the most significant contributor to higher early yields in the experiment.[13] Blocks planted at 363 trees per acre contributed a 57% of normalized gains (measured as soluble solids pounds per acre) compared to a 22% contribution of drip fertigation - open hydroponics, and 21% of rootstock. Planting density affects investment profitability. By choosing a low density, a grower foregoes potential revenue. Planting too many trees, on the other hand, increases costs and may diminish yield per tree since neighboring plants would compete for nutrients and sunlight utilization by the crop canopy. In practice, growers decide the planting density according to their groves' particular conditions and the planting density within ranges considered best practices.

Plants in this experiment were attacked by HLB. The incidence of HLB was statistically higher and more severe on plants cultivated under conventional practices than under APS. While "[APS] failed to avoid infestation… or to adequately offset the symptoms of HLB once trees

14

became infected" (Gruber et al. 2015, p. 10), APS components optimize early yields and partially mitigate HLB. "HLB-affected trees will remain smaller, with lower yields per tree – conditions which are better dealt with and compensated for with high planting densities and APS than with traditional low densities and conventional citriculture." (Schumann et al. 2012, p. 8).

Possibly due to APS, orange growers in Florida are adopting high density. Prior to HLB, orange trees were planted at densities around 150-175 trees per acre. Currently, the density of new plantings by small and medium growers is estimated around 225 trees per acre. Large growers could afford to plant at higher planting densities and APS, which increases establishment and production costs. Best practices on planting density vary over time, and depend upon the prevailing citriculture technology. During the 1950s, for instance, orange groves in Florida were planted at about 70 trees per acre. As freezes in the 1980s devastated many of those groves, new plantings moved further south with tree densities reaching 145 trees per acre with the aid of better technology allowing for higher density (Goldberg and Hogan 2004). Given the perennial nature of citrus cultivars, densities significantly vary during structural industry changes that require new plantings, such as natural disasters or epidemic diseases.

Citrus replanting incentive programs

Governmental agencies have programs implemented to help citrus growers to reduce the risk of a new or renovated grove investment. Singerman (2016) summarizes these programs. We next highlight the features of the programs that relate to the grove investment model. Private entities have also implemented programs to incentivize citrus replanting.

Announced in 2014, the *Tree Assistance Program* (TAP), by the USDA Farm Service Agency (FSA), reimburses growers for replanting trees lost to the effects of HLB. The TAP provides cost-sharing financial assistance after the grove accumulates tree mortality in excess of

18% over a period up to six years. In particular, the program covers 65% of cost per tree and planting cost and 50% of site preparation, subject to eligibility provisions and with capped support. Based on to characteristics of the TAP, Spreen and Zansler (2016) note that this program is only available to small- to medium-sized growers because of income limits imposed by the government. The goal of the TAP is to reach a large number of growers in Florida, as its target is to have 6 million new trees planted by 2018. In general, the TAP is a support program limiting resetting costs in case of severe HLB attacks.

The *Citrus Grove Renovation / Re-establishment Support Program* (CGRR) is a relatively new program available to Florida growers, announced in August 2016. CGRR is a program implemented by the FDACS. This support is limited to growers planting an entire grove and targets investments in irrigation and nutrient management systems. As discussed previously, one of the strategies currently used by against HLB precisely involves these investments. CGRR would cover 100% of the cost of engineering and design and 75% of investments that qualify for improvement of irrigation and nutrient management systems. Similar to the TAP, the CGRR is subject to eligibility provisions and pre-established capped amounts. While table 1 provides the investments required to establish a traditional grove, the CGRR program gives room for technology improvement, particularly for technology targeted to contain the negative effects of HLB.

The *Abandoned Grove Abatement Initiative* (AGAI) is another support program by the FDACS. AGAI supports growers for the removal and destruction of abandoned groves due to HLB, to reduce the spread of the pathogen. Thus, a grower planting a new grove in Florida, eligible for AGAI, would avoid this cost and focus on the establishment costs instead (table 1). In any case, removal costs are considered sunk costs for capital budgeting purposes, as they need to be

incurred regardless of the decision to re-plant the grove with citrus or use it for other purposes. An additional benefit of the AGAI for landowners is the fact that it provides tax benefits related to land values if the farmer decides to replant citrus.

Private entities have also programs to incentivize replanting of orange groves, however these programs are not available to a typical grower in Florida, but rather to growers with ties to those firms. Minute Maid, the subsidiary of the Coca-Cola company, has a program consisting on a long-term contract offered to growers (refer to Spreen and Zansler 2016). Florida's Natural announced in 2014 major commitments to incentivize citrus plantings in Florida and renewed the program in 2017 (refer to Trejo-Pech, Spreen, and House 2017).

Expedited depreciation

A bill on tax reduction, expected to benefit Florida citrus growers was introduced in the United States Senate in September 2016. If passed, the Emergency Citrus Disease Response Act of 2016, would allow citrus growers to apply expedited or accelerated depreciation for income tax purposes. That is, instead of accumulating grove establishment costs and early caretaking costs during the non-bearing portion of grove life (as discussed in the "establishment and early caretaking" section), costs would be "expensed" or reported in the income statement the year incurred. Reporting expenses earlier rather than later in the investment horizon alleviates growers' cash flow needs particularly during the non-productive grove period. The overall value of a grove improves due to the time value of money. According to the model in this study, the value of grove would increase about $600 USD per acre by using expedited depreciation instead of normal depreciation, as currently allowed by the IRS.

Consumption

Consumption of orange juice per capita in the U.S. has decreased from 4.9 gallons in the 2005-06 season to 2.6 gallons in 2015-16 (FDOC, 2016). During the last decade, however, orange supply has decreased faster than consumption, causing an increase in imports (figure 2). During recent years, there has been public concern on the connection between consumption of fruit drinks with added sugars and high levels of calories and increased risk for health. (The juice industry, according to Euromonitor's classification, is comprised of (100%) juices, nectars (with 25% to 99% juice content), and juice drinks (containing up to 24% juice).) Despite its high sugar content, fruit beverages are an important source of vitamins and minerals and represent a cost-effective and convenient way to meet consumers' daily fruit intake recommendations (Leschewski, Weatherspoon, and Kuhns 2016). This has allowed beverage companies to successfully launch juices fortified with vitamins and minerals, and campaigns that emphasize the naturally occurring nutrients in juices. A recent study by Tetra Pak, finds potential for the growth of the beverage industry, particularly for 100% juices (Crawford 2016). According to the study (1) 67% consumers rate "all natural" as the most interesting juice attribute; (2) vegetable blends is a growing category, attracting customers probably because they have lower natural sugar and offer different nutrients; and (3) 60% of consumers look for juices with proven medical benefits, the so called functional products.

A potential opportunity for the increase of orange juice consumption is the forthcoming change on food and beverage labels. In May 2016 the Food and Drug Administration (FDA) released the new design of the nutrition facts label on packaged foods, which will become effective in the summer of 2018. According to the FDA, new labeling will reflect new scientific information, including the link between diet and diseases such as obesity and heart disease. Among the changes that may impact orange juices, are the following: (1) Contents of vitamin D

and potassium will be declared in the label, replacing vitamin A and C, which may continue to be labeled but will not be mandatory. (2) A new line, indicating the amount of "added sugar" will be required in new labeling. (3) Declaration of total calories will be required in larger font.

The new label design might stimulate orange juice consumption. The high level of potassium naturally inherent in oranges could be emphasized by marketers. Orange juice has the second highest level of this nutrient across commercially available juices, only following prune juice (Leschewski, Weatherspoon, and Kuhns 2016). Given the mandatory requirement to include potassium content in labels, the U.S. population is more likely lacking potassium compared to other nutrients. The fact that 100% orange juice has no added sugar is another element to emphasize. Signifying that there is 0% added sugar on the label for 100% orange juice would likely appeal to consumers by allowing them to differentiate between natural sugar and added sugars. According to Euromonitor (2016), 100% orange juice represented around 50% of the total 100% juice volume consumed in the U.S., including all flavors, in every year from 2010 to 2015 (Trejo-Pech, Spreen, and House 2017).

Size of grove

The baseline model in this study is presented on a one acre basis. While it would be difficult to define small, medium, and large orange growers, for this study a small grower is one with up to 200 acres cultivated, a medium-sized grower has 200 to 500 acres, and a large grower has more than 500 acres. Grower size may capture scale effects of fixed costs and bargaining power on selected inputs. We mention a few instances where grower size affects profitability. Caretaking costs may be lower for a large grower, as orange farmers typically receive discounts for bulk purchases (Singerman 2015), and small growers may have higher caretaking costs. Financial costs

could also be affected. The opportunity cost of capital for a large grower might be lower relative to a small grower as access barriers to capital and interest rates could be lower.

Concluding remarks

This study presents a capital budgeting model to evaluate a potential orange grove investment. The study features a representative grower in Southwest Florida with his grove infested by HLB to a degree that makes no economic sense to keep maintaining it. The grower has the choice to replant the grove or to convert the land to other uses. Support for citrus growers, by both governmental and private entities, and growers' experience on orange may induce farmers to keep growing oranges. We provide results of a baseline model, along with Monte Carlo simulation. Student using this case study are expected to challenge the baseline assumptions and replicate the model with alternative scenarios. Ultimately, they should discuss whether it is optimal to continue growing oranges in Florida, considering both financial metrics, and risks and opportunities. Regarding the next-best alternative to replanting oranges, the grower may choose to consider alternative crops to plant. Some alternative crops, emerging due to HLB mainly, include but are not limited to peaches, olives, and blueberries. An analysis of alternative crops is not covered in this study. The CREC has recently published a profitability study on blueberries (Singerman et al. 2016). Compared to oranges, planting blueberries require a significantly higher investment of above $35,000 per acre for the first year. According to that study, which presents alternative price and yield scenarios, blueberry gives positive NPVs at moderate yield and high prices, using 10% as cost of capital. At the same time, blueberry prices have varied year over year, and the infrastructure is still in the developmental phase. Finally, the representative orange grower featured in this study, may decide to rent or sell its land, this option is out of the scope of this study.

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Table 1- Establishment and Early Caretaking Costs for a Conventional Grove in Southwest Florida

	Year 0	Y1	Y2	Y3	Y4
Tree removal and land preparation	933.3				
Irrigation investments	1,093.3				
Tree cost	1,912.5				
Staking, planting and watering	371.3				
Weed control		85.3	93.9	102.4	110.9
Sprays		200.5	215.5	181.3	196.3
Fertilizer		161.1	177.1	193.1	209.1
Sprouting		27.7	27.7	0.0	0.0
Irrigation		104.5	115.2	125.9	136.5
Disease related		24.5	27.7	29.9	32.0
Indirect costs		42.7	45.9	45.9	49.1
Establishment costs	4,310.3	646.4	702.9	678.4	733.8

Notes: Per acre estimations by Morris, Muraro, and Castle (2011), adjusted by authors as follows. a) Figures were adjusted by the CPI as of the end of 2016 USD values, b) Tree cost is expressed in terms of 225 trees per acre, and c) cost per tree is $8.5 as in Spreen and Zansler (2016).

Sprays include insecticides, fungicides, and foliar nutrients. Indirect costs include supervision, overhead, and miscellaneous. Morris, Muraro, and Castle (2011) estimated $260 per acre in permits and fees. We removed this cost from the table since it represents sunk cost for replanting decisions, as permits already exist.

Table 2- Cost of Production for Processed Oranges Grown in Southwest Florida, Selected Seasons

Item / Season	2005-06	2014-15	2015-16
Weed control	197.2	248.2	210.1
Spray Program[1]	143.9	666.0	611.6
Fertilizer	207.9	487.0	454.2
Pruning	28.7	31.5	49.8
Irrigation[2]	166.7	198.1	180.9
Other HLB related[3]		20.6	18.0
Citrus Canker[4]	29.4		
Total w/o resets	773.9	1,651.3	1,524.6
Resets			
Trees per acre	4.0	9.0	9.0
Cost per tree	34.2	38.5	42.9
Tree removal, site preparation and planting (trees included)	20.1	19.1	17.5
Supplemental caretaking (year 1 to 3)	14.2	19.5	25.4
Resets per acre	137.0	346.8	385.7
Indirect costs[5]	109.0	92.1	160.0
Total per acre	1,019.9	2,090.2	2,070.2

Source: Adapted by authors from the Southwest Florida Orange Budget Costs by the Citrus Research and Education Center, IFAS-UF. Accessed online on April, 2, 2017:

http://www.crec.ifas.ufl.edu/extension/economics/.

Notes: [1]Includes insecticides, fungicides, and enhanced foliar nutrients. [2]Depreciation charges, originally included in the budget reports up to the 2011-12 season, are excluded by authors. [3]Includes tree removal and site cleanup preparation, field inspections for HLB, and Citrus Health Management Areas (CHMA) program cost. [4]Mandatory citrus Canker decontamination cost. [5]Includes management costs and taxes/regulatory costs. Interests, originally included in the budget reports, are excluded by authors.

Table 3- Harvesting and Hauling Costs for Processed Oranges in Southwest Florida, Early-Mid Varieties

Item / Season	2005-06	2014-15	2015-16
Harvesting ($ per box):			
Weigh. Avg.	1.945	1.990	2.440
Minimum	1.550	1.680	1.880
Maximum	2.750	2.350	3.420
Hauling ($ per box according to mileage in left column):			
1 to 30	0.428	0.370	0.440
31 to 50	0.498	0.470	0.530
51 to 80	0.632	0.599	0.610
81 to 100	0.735	0.776	0.700
100 +	0.840	0.960	0.640

Source: Citrus Research and Education Center, IFAS-UF, adapted by authors. Accessed online on May, 4, 2017: http://www.crec.ifas.ufl.edu/extension/economics/harvesting_charges.shtml

Table 4- Weekly Yields and Prices for Early-Mid Oranges for Processing in Florida, Selected Seasons

Week	PS/box	$/PS	Week	PS/box	$/PS
12.13.14	5.401669	1.895000	12.12.15	5.282889	
12.20.14	5.476924	1.960000	12.19.15	5.394349	2.134000
12.27.14	5.590675	1.927000	12.26.15	5.477772	2.083000
01.03.15	5.680583	1.941000	01.02.16	5.552435	2.056000
01.10.15	5.827209	1.980000	01.09.16	5.646660	2.093000
01.17.15	5.867688	1.972000	01.16.16	5.702282	2.144000
01.24.15	5.951620	1.934000	01.23.16	5.807152	2.144000
01.31.15	6.042775	1.920000	01.30.16	5.786693	2.149000
02.07.15	6.045265	1.921000	02.06.16	5.857623	2.158000
02.14.15	6.137405	1.918000	02.13.16	6.006673	2.171000
02.21.15	6.237169	1.900000	02.20.16	6.027005	2.240000
Mean				5.734738	2.012386
St. Dev.				0.293539	0.138036

Source: Yields from the Florida Department of Citrus (FDOC)'s Annual Processor's Report, 2014-15 and 2015-16 seasons.

Notes: Yields are expressed in pounds solids per box, and prices in dollars per pound solid (yields for tangerines and eliminations included). Post-estimate weekly prices, USD per pound solid, are final spot and contracted prices established for current fruit season only, reported by the FDOC.

Prices from the beginning of the season, particularly when the total level of production is very low, are significantly lower than regular prices during the rest of the season. Thus, data when production level did not reach 1 million 90-lb boxes per week are excluded from table 4.

Table 5- Yield per Tree Age for Early-Mid Oranges in Florida, in 90-lb Box per Tree for Southern Florida

	3 to 5 years	6 to 8 years	9 to 13 years	14 to 23 years	24+ years
Prior to HLB					
2004-05	1.00	2.70	2.50	3.50	3.90
During HLB					
2011-12	1.40	1.70	2.30	2.70	3.80
2012-13	0.50	1.10	2.10	2.50	3.70
2013-14	0.30	1.10	1.90	2.20	3.10
2014-15	1.00	1.00	1.20	2.30	3.10
2015-16	0.50	1.60	1.90	1.40	2.40
Weighted average during HLB	0.70	1.40	1.90	2.30	3.10

Source: Florida Citrus Statistics, USDA NASS, 2015-16 (March 2017) and 2008-09 (May 2010).

Accessed online on May 5 2017:

https://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Citrus/

Table 6- Projected Free Cash Flows for the Baseline Orange Grove

| Year	0	1	2	3	4	5	6	7
Establishment + EC ($ grove)	3617.0	646.4	702.9	678.4				
Revenues ($ grove)					1480.5	1480.5	2960.9	2960.9
Productive trees (trees per acre)					183.3	183.3	183.3	183.3
Volume (pound solids per acre)					735.7	735.7	1471.4	1471.4
Oper. Costs & Exp. ($ grove)	0.0	351.8	355.0	355.0	2935.8	2935.8	3284.1	3284.1
Caretaking w/o resets ($ grove)		0.0	0.0	0.0	1588.0	1588.0	1588.0	1588.0
Spray program ($ per acre)					638.8	638.8	638.8	638.8
Fertilizer program ($ per acre)					470.6	470.6	470.6	470.6
Other caretaking ($ per acre)					478.6	478.6	478.6	478.6
Reset ($ grove)		309.1	309.1	309.1	309.1	309.1	309.1	309.1
Tree removal ($ per acre)		219.5	219.5	219.5	219.5	219.5	219.5	219.5
Supp. caretaking ($ per acre)		89.6	89.6	89.6	89.6	89.6	89.6	89.6
Harvesting & Haul ($ grove)					348.3	348.3	696.6	696.6
Harvesting ($ per acre)					284.2	284.2	568.3	568.3
Hauling ($ per acre)					64.1	64.1	128.3	128.3
Indirect costs ($ grove)		42.7	45.9	45.9	126.0	126.0	126.0	126.0
Indirect costs ($ per acre)		42.7	45.9	45.9	126.0	126.0	126.0	126.0
Depreciation ($ grove)		0.0	0.0	0.0	564.5	564.5	564.5	564.5
Operating Income	0.0	(351.8)	(355.0)	(355.0)	(1455.3)	(1455.3)	(323.2)	(323.2)
Income taxes	0.0	(105.5)	(106.5)	(106.5)	(436.6)	(436.6)	(97.0)	(97.0)
NOPAT	0.0	(246.2)	(248.5)	(248.5)	(1018.7)	(1018.7)	(226.2)	(226.2)
Free Cash Flow	(3617.0)	(892.6)	(951.4)	(926.8)	(454.3)	(454.3)	338.2	338.2
Terminal Value								
FCF + Terminal Value	(3617.0)	(892.6)	(951.4)	(926.8)	(454.3)	(454.3)	338.2	338.2

Notes: Tree removal also includes site preparation and planting costs (including cost of trees).

NOPAT is Net Operating Profit After Taxes.

Table 6- Continued

Year	8	9	10	11	12	13	14	15
Establishment + EC ($ grove)								
Revenues ($ grove)	2960.9	4018.4	4018.4	4018.4	4018.4	4018.4	4864.4	4864.4
Productive trees (trees per acre)	183.3	183.3	183.3	183.3	183.3	183.3	183.3	183.3
Volume (pound solids per acre)	1471.4	1996.8	1996.8	1996.8	1996.8	1996.8	2417.2	2417.2
Oper. Costs & Exp. ($ grove)	3284.1	3532.9	3532.9	3532.9	3532.9	3532.9	3167.5	3167.5
Caretaking w/o resets ($ grove)	1588.0	1588.0	1588.0	1588.0	1588.0	1588.0	1588.0	1588.0
Spray program ($ per acre)	638.8	638.8	638.8	638.8	638.8	638.8	638.8	638.8
Fertilizer program ($ per acre)	470.6	470.6	470.6	470.6	470.6	470.6	470.6	470.6
Other caretaking ($ per acre)	478.6	478.6	478.6	478.6	478.6	478.6	478.6	478.6
Reset ($ grove)	309.1	309.1	309.1	309.1	309.1	309.1	309.1	309.1
Tree removal ($ per acre)	219.5	219.5	219.5	219.5	219.5	219.5	219.5	219.5
Supp. caretaking ($ per acre)	89.6	89.6	89.6	89.6	89.6	89.6	89.6	89.6
Harvesting & Haul ($ grove)	696.6	945.4	945.4	945.4	945.4	945.4	1144.4	1144.4
Harvesting ($ per acre)	568.3	771.3	771.3	771.3	771.3	771.3	933.6	933.6
Hauling ($ per acre)	128.3	174.1	174.1	174.1	174.1	174.1	210.8	210.8
Indirect costs ($ grove)	126.0	126.0	126.0	126.0	126.0	126.0	126.0	126.0
Indirect costs ($ per acre)	126.0	126.0	126.0	126.0	126.0	126.0	126.0	126.0
Depreciation ($ grove)	564.5	564.5	564.5	564.5	564.5	564.5		
Operating Income	(323.2)	485.5	485.5	485.5	485.5	485.5	1697.0	1697.0
Income taxes	(97.0)	145.7	145.7	145.7	145.7	145.7	509.1	509.1
NOPAT	(226.2)	339.9	339.9	339.9	339.9	339.9	1187.9	1187.9
Free Cash Flow	338.2	904.3	904.3	904.3	904.3	904.3	1187.9	1187.9
Terminal Value								15838.2
FCF + Terminal Value	338.2	904.3	904.3	904.3	904.3	904.3	1187.9	17026.1
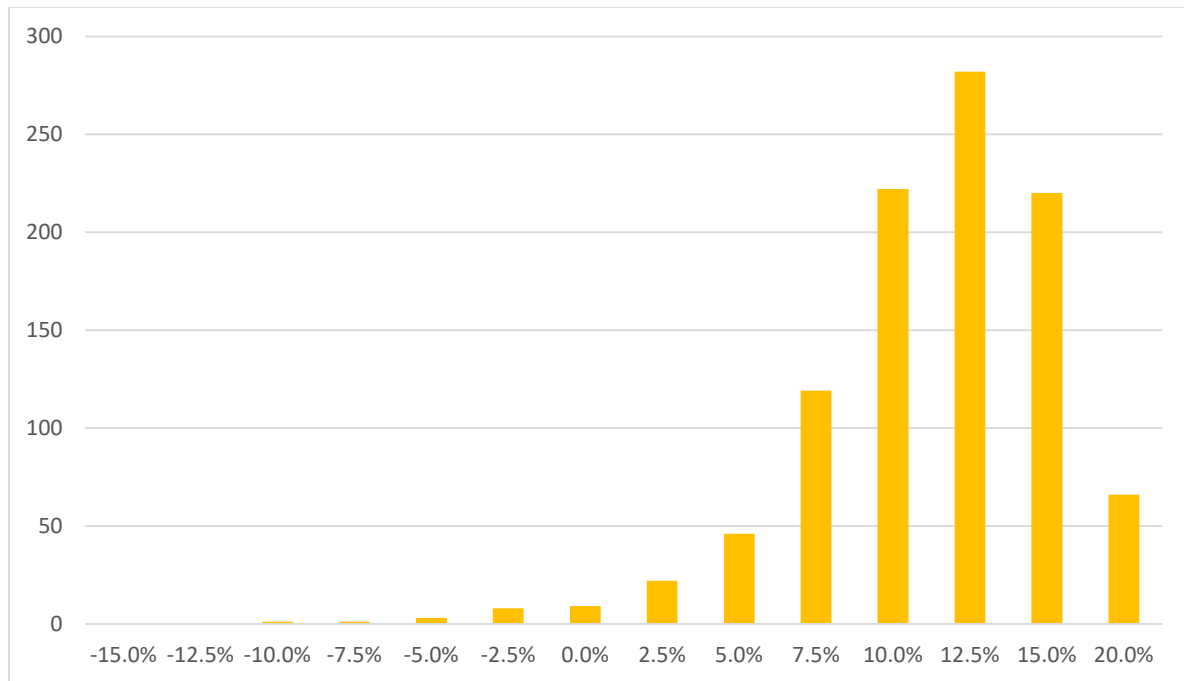
Figure 1- Distribution of Modified Internal Rate of Return results for 1,000 Monte Carlo simulations
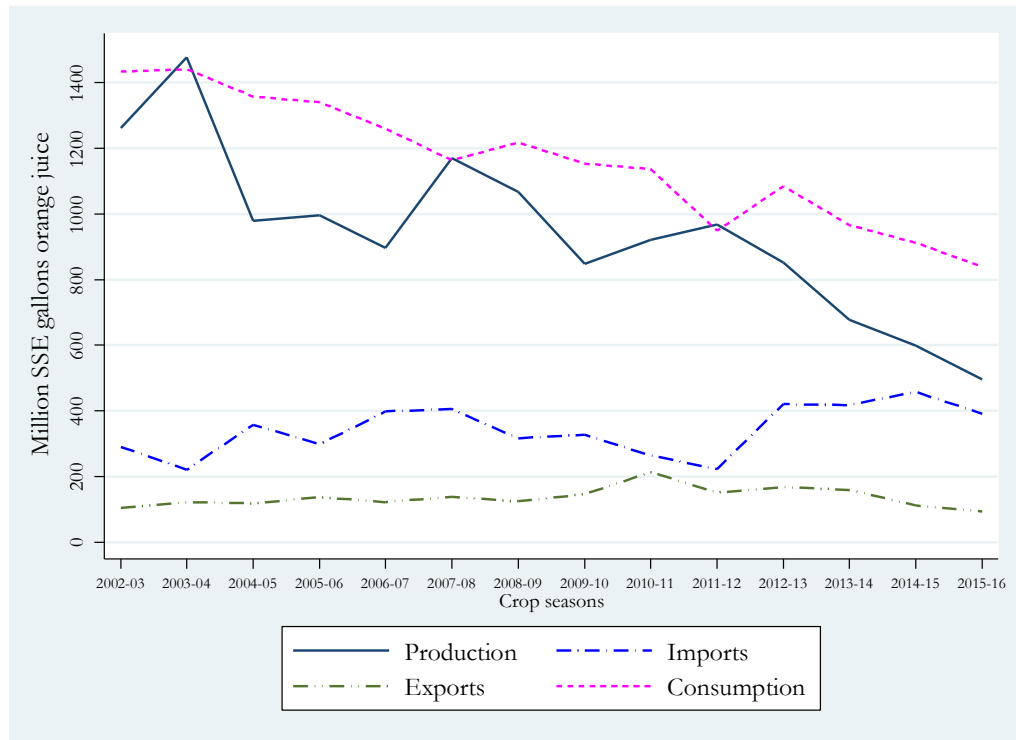
Figure 2- U.S. Orange juice production, imports, exports and presumed consumption

Source: Prepared by using data in Zansler (2016).

Footnotes

1. The Florida citrus harvest and marketing seasons extends from November 1 to October 31 of the following year.

2. The USDA's National Institute of Food and Agriculture, for instance, awarded about $14 million grants in 2017 to four research institutions to fight HLB (Johnson 2017).

3. Early-mid varieties of oranges in Florida include Hamlin, Pineapple, and Mid-Sweet. They are typically harvested between late November and February. Valencias, also known as late orange, is harvested between March and June. Early-mid and late varieties have different production costs, prices and yields. In Florida, during the last two seasons, approximately 47% of total orange production was from early-mid varieties.

4. When reestablishing an entire grove, revenues from commercially productive trees, if any, are foregone. Foregone revenues (and foregone costs) are not considered in this model for project evaluation purposes since it is assumed that the decision to reestablish an entire grove is made by the grower when the grove generates negative Net Present Value.

5. Although in the case of replanting an existing plot, part of the irrigation system is already in place.

6. Investment in working capital is assumed to be zero, implying that investment in current assets (inventories and account receivables) equal investment in current liabilities (excluding short-term loans).

7. The MIRR provides a more conservative rate of return than the conventional Internal Rate of Return (IRR) since it uses a more realistic reinvestment rate (e.g., the opportunity cost of capital in this instance). In general, the MIRR provides a more accurate metric than the IRR (Kierulff 2008). The MIRR is also less prone to errors when simulation analysis is

performed, as in this study. When simulating results many times, there is a possibility that in some cases cash flows change signs more than one time over the investment horizon producing an incorrect IRR or simply producing errors in the spreadsheet.

8. The expected inflation rate of the baseline model is assumed 0%. Using 1% inflation changes MIRR from 9.5% to 10.4%.

9. Other species of the bacterium are Candidatus L. africanus, the cause of HLB in Africa and Candidatus L. Americanus, affecting some regions in Brazil (Mead and Fasulo 2014).

10. Including both macro nutrients (Nitrogen, Phosphorus, and Potassium salts) and micro nutrients (Magnesium Boron, and Zinc salts).

11. Other control strategies under evaluation include thermal and antimicrobial treatments, not widely used yet due to practicality of implementation or regulatory hurdles (McCollum and Baldwin 2016).

12. The overall APS's aim was stated as: "…enhance citrus production and reduce abiotic stress and disease pressure by optimizing daily water and nutrient levels for trees growing on sandy soils. This system also promotes rapid canopy development by incorporating high planting densities" (Schumann, Syvertsen, and Morgan 2009, p. 108).

13. Planting density is defined as the number of trees per acre.