*Proc. Fla. State Hort. Soc.* 124:119–122. 2011.

# Economic Arguments for and against Tree Eradication to Control HLB

Fritz M. Roka*

*University of Florida/IFAS, Southwest Research and Education Center, 2685 State Road 29 North, Immokalee, FL 34142*

Additional index words. profits, net present value, risk, nutritional therapy

**Management of HLB (*Candidatus* Liberibacter asiaticus) through eradication of symptomatic trees has to be considered in the context of current public policy, state of scientific knowledge, and economic factors important to individual growers. This paper reviews the economic conditions that drive grower decisions toward either tree eradication to control HLB inoculum or toward nutritional therapies that attempt to maintain production from HLB infected trees. Individual grower incentives may not necessarily coincide with overall industry welfare.**

A plant pathologist's approach to citrus greening, or HLB (*Candidatus* Liberibacter asiaticus), is direct and straightforward—control vector populations (psyllids) and reduce the bacteria inoculum, which in the case of HLB means removing "symptomatic" trees. For the most part, Florida citrus growers have embraced new programs to control psyllid populations. As to removing symptomatic trees, however, a passionate debate has been raging for the past four years between two camps, those who argue that aggressive eradication of symptomatic trees is the only salvation in the Florida citrus industry's battle with HLB, and those who argue that nutritional therapies would allow a grower to "live with" HLB by maintaining production from infected trees. The objectives of this paper are two-fold. First, present purposely dispassionate economic arguments about the extent to which a tree eradication program is the best strategy to manage an individual grower's HLB problem. Second, discuss how individual grower decisions could collectively affect the entire industry. While this paper presents economic arguments, it does NOT present any estimates of costs or benefits from following either a tree eradication program or a nutritional therapy program. Rather, the economic arguments presented in this paper should help anticipate and explain grower behavior that, in turn, can foster a more constructive discussion about how HLB can be best addressed by both individual growers and the collective community of Florida citrus growers.

## Institutional Facts—A Starting Position

Any economic analysis or policy discussion about HLB must be defined in the context of the existing institutional setting. The current HLB institutional setting in Florida can be outlined by three facts:

1) No public policy is currently in place that explicitly directs growers on how to handle HLB-infected trees.

2) When HLB was first confirmed in Florida five years ago, the scientific community possessed relatively little knowledge with respect to the physiology of the liberibacter bacteria (Las), life cycle dynamics of the Asian citrus psyllid (*Diaphorina citri*, Kuwayama), and how Las manifests inside a tree's phloem.

3) For the most part, citrus growers act as individual agents and are in business to earn a profit.

Unlike citrus growers in Sao Paulo, Brazil, Florida growers are not under any state or federal law that requires the removal of symptomatic HLB trees. The eradication of symptomatic trees in Florida is a *recommendation* by university and government scientists who argue that any infectious disease should be controlled through reduction, if not elimination of the inoculum sources and reduction, if not elimination of any vector that spreads inoculum.

A lack of any coordinated approach to control HLB in Florida is in large measure a result of a failed citrus canker program that immediately preceded the first confirmation of HLB infection in Florida. When canker bacteria first spread into Florida's commercial groves in 1998, strict federal regulations were in place to not only remove infected trees but also remove all "exposed" trees within 125 ft of each infected tree (Graham et al., 2004). The zone of exposed trees was increased to 1,900 ft in 2001 as more field data suggested that a wider circle of tree eradication was necessary to more effectively control the spread of canker (Graham et al., 2004). Equally important to the federal tree eradication policy was the stipulation that growers would be financially compensated for the loss of any removed trees.

For a variety of reasons, the canker control program failed. A tree eradication protocol could not completely control inoculum levels before a series of hurricanes in 2004 and 2005 spread canker bacteria across the entire Florida citrus production region. In Jan. 2006, the federal government suspended compensation payments to growers and at the same time shifted its policy position from mandatory eradication of canker infected trees to "strongly recommending" that infected trees be removed. While HLB is a far more serious disease than canker, neither government agencies nor citrus growers in 2006 had the intestinal fortitude to enter into another mandatory tree eradication program.

Science based information to control HLB in 2006 was limited to a plant pathology model of controlling the vector (Asian Citrus Psyllid) and removing symptomatic trees to reduce inoculum levels of the liberibacter (Las) bacteria. Limited knowledge was available to explain such things as feeding habits of psyllids, range

*Corresponding author; phone: 239-658-3400; email: fmroka@ufl.edu

and general movements of psyllid populations, and the duration of the latency period between when a tree was first infected with liberibacter and when the tree began to express visual symptoms. Pathologists could not (and still cannot) culture liberibacter in a lab environment to study its physiology and test various chemical treatments that could suppress its effects on a tree's phloem. By 2006, the Asian Citrus Psyllid was endemic throughout Florida's citrus production region. Consequently, even if every citrus tree in Florida were eradicated, "hot" psyllids (those carrying liberibacter) could continue to survive on non-citrus host plants such as orange jasmine [*Murraya paniculata* (L.) Jack] (Tsai et al., 2002). Citrus growers faced the unsettling reality that the plant pathology model could not guarantee that a tree eradication program could salvage the economic viability of their individual orchards.

In 2007 Maury Boyd, a citrus grower in southwest Florida, began to argue that nutritional therapies could be an alternative approach to the eradication of symptomatic trees. His hypothesis was that nutritional deficiencies manifested by HLB could be treated through foliar applications of micro and macro nutrients. While this approach would not cure HLB infection, it might allow infected trees to maintain production. Despite being heavily infected by HLB, the appearance of Mr. Boyd's trees in his Orange Hammock grove near Felda, FL, improved markedly. More importantly, his trees continued to produce fruit and at levels higher than regional averages. Scientists at the UF/Southwest REC and Citrus REC began to experiment with similar nutritional cocktails as what Mr. Boyd proposed, and yield results from these field trials are just beginning to be compiled.

Many scientists, particularly plant pathologists, do not believe that nutritional therapies can have a long term effect on infected HLB trees. Pathologists argue that nutritional amendments will not stop the spread of HLB bacteria within an infected tree and eventually an infected tree will cease to produce fruit no matter how much nutrients are applied through its leaves. More importantly, not controlling HLB inoculum today increases the likelihood that newly planted trees tomorrow will not survive to become fully productive. Cost of additional nutrients is another factor. The nutritional cocktails currently being applied by an increasing number of growers increase overall annual grove care costs by between $200 and $600 per acre, above the estimated costs from following the recommended protocol of tree scouting and removal of infected trees (Muraro, 2010). The pertinent economic question becomes whether the value of maintaining an infected tree with nutritional therapies more than offsets the increase in annual production costs. The question is complicated by the fact that the extent and duration for which a nutritional therapy can sustain viable levels of fruit production remain uncertain. Furthermore, is it possible to plant new citrus trees in blocks heavily infected with HLB and have those trees reach productive maturity?

## Perspective 1: Growers as Individual Islands

Grower decisions with respect to HLB management depend on both individual circumstances as well as the collective actions of other growers. The next section of this paper discusses grower behavior from the perspective that growers act as individuals and independent of actions by their citrus neighbors. In other words, each grower is an "island." This discussion begins with the premise that a citrus grower is in business to earn a profit as summarized by equation 1:

$$\pi = (P \times Q) - (C) \qquad (1)$$

Profits (π) are determined by the difference between revenues ($P \times Q$) and cost ($C$). In the case of juice oranges, fruit revenues equal the amount of total pound solids produced ($Q$) multiplied by the delivered-in fruit price ($P$). Cost ($C$) includes grove care expenses, harvesting, fruit hauling, grower taxes, and all non-cash costs associated with capital asset depreciation and interest on average investment. Equation (1) reflects profits in a given year. As costs to control psyllids increase and/or as production decreases with the removal of symptomatic trees, grower profits fall. Since citrus is a perennial crop, however, grower profits have to be evaluated over several years. The economic argument presumption of a tree eradication program is that the income forgone from pushing symptomatic trees today will be more than offset by the value of citrus produced tomorrow which, in turn, can only be realized by controlling HLB inoculum *today*. In other words, decisions made today will have consequences on profits throughout a grower's planning horizon. A meaningful way to represent grower profits over time is to calculate the net present value of a stream of estimated annual returns based on a specific management strategy.

$$NPV_a = \sum_{t=0}^{n} \frac{\pi t}{(1+i)^t} \qquad (2)$$

The net present value ($NPV_a$) of management option (a) is the sum of annual profits (π) over a planning horizon of $n$ years divided by a discount factor $[(1+i)^{-t}]$. As annual profits increase, *NPV* increases as well. But *when* profits accrue during the planning horizon has an important effect on *NPV*. For example, the cumulative profits over a defined planning horizon from following management option (a) may be greater than the cumulative profits from management option (b). Option (b), however, may still yield a higher *NPV* if most of its profits are earned in the early years and therefore are less affected by the grower's discount factor. In other words, a dollar earned today is always worth more than a dollar earned tomorrow. The discount factor expresses future profits in today's dollars and thereby allows *NPV* estimates among various options to be directly compared. The interest rate ($i$) reflects an individual's judgment about future risk or uncertainty with respect to future profits. A higher interest rate reflects a higher degree of risk or uncertainty. The *NPV* decreases with higher risk and uncertainty, as reflected by a higher value for the interest rate ($i$).

Imagine two identical blocks of mature sweet oranges. Both face the same level of HLB and psyllid pressure. Psyllids are controlled equally in both blocks, but in Block A, HLB symptomatic trees are removed, while in Block B, infected trees are not removed, and instead receive foliar nutritional treatments. The *NPV* provides a framework within which to compare the estimated financial returns from following either tree eradication or a nutritional therapy as a basis to manage HLB. As stated previously, nutritional amendments can increase total annual grove care costs by at least $200 per acre more than if the standard HLB protocol was followed, that is tree scouting and removal of HLB infected trees. In the initial year of HLB management (t=0), production, and hence revenues, between the two blocks is equal, but the nutritional program in Block B reduces profits by the cost of the nutritional program. This cost differential between blocks A and B continues through the entire planning horizon ($n$).

During the first year, HLB symptomatic trees in Block A are removed. Fewer trees translate to lower production and, hence lower revenues in subsequent years. The extent to which production falls is dependent on the answers to three questions. First, what is the current percentage level of symptomatic trees (point

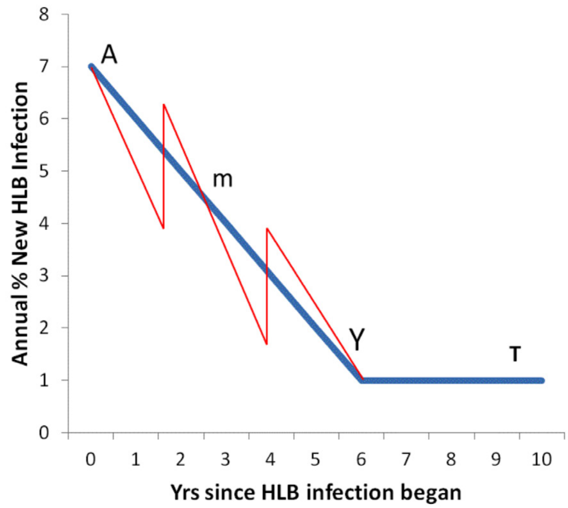


Fig 1. Hypothetical decline in new HLB infections from a tree eradication program.

A, Fig. 1)? Second, what is the feasible and long run minimal level of inoculum control as measured by the annual percentage of finding and eradicating newly symptomatic trees (level T, Fig. 1)? Third, how long (i.e., number of years) will it take to move from A to T (point Y, Fig. 1)? Knowing points A and Y, simple geometry suggests that the slope of the line (m) between points A and Y is an average annual percentage of tree losses from removing HLB symptomatic trees. Field experiences in Florida and Sao Paulo, Brazil, indicate that the transition from points A to T follows a pattern as shown by the red line in Fig. 1 (Dewdney and Graham, 2009). The "saw-tooth" pattern reflects the latency period of HLB expression and those only symptomatic trees are being removed at any given time.

An individual grower's decision with respect to managing HLB is complicated by a number of factors, around each of which are varying degrees of uncertainty. At the present time, the latency period of HLB within a tree limits the effectiveness of a tree eradication program based only on visible identification of symptomatic trees. With respect to a nutritional therapy program, field data does yet exist to inform a grower as to the likelihood of how long and to what extent production can be maintained from an infected tree. At best, the academic community can offer growers only qualitative guidelines as to the likelihood that an aggressive tree eradication program would be financially superior to an alternative nutritional therapy program.

Eight factors are summarized in Table 1 and are based on the information embedded in Figure 1 and Equations (1) and (2). The higher the percentage of symptomatic trees a grower finds in his/her HLB scouting regime, the less likely a tree eradication strategy will yield a higher NPV than a nutritional therapy. Conversely, the lower the long-term base HLB inoculum level and the fewer number of years it takes to achieve that minimum base level, the more likely a tree eradication program would be more profitable than following a strict nutritional therapy program. Likewise, the longer a grower's planning horizon, the more important the value of the next generation of citrus trees will be and the more likely a tree eradication program should be adopted today. However, the more uncertain a grower feels about the future (for whatever reason), the higher the interest rate will be in his/her discount factor. As a result, profits earned in the near term will be more heavily weighted than the profits expected to be earned toward the end of the grower's planning horizon. For similar reasons, the higher the expected market price the more expensive it becomes to remove infected but still productive trees.

Much debate has focused around the potential of a nutritional therapy to maintain production of infected trees. This debate will be answered over time as data from field trials and grower experiences are accumulated. The longer HLB infected trees can produce an economically viable crop (i.e. positive annual profits), the less financially attractive a tree eradication program becomes.

## Perspective 2: Growers as Part of a Larger Community

In the previous section of this paper, growers were discussed as individual and separable entities. In reality, however, actions by one grower affect his or her citrus neighbors. "Externality" is economic jargon to say that actions of one grower may impose an unwanted cost on another grower. For instance, citrus growers in Brazil and Florida who aggressively follow a tree eradication program complain about their neighbors who follow little, if any psyllid control, and do not remove symptomatic trees. These "bad neighbors" impose costs in terms of increasing the number of trees that have to be removed by those growers trying to follow an aggressive HLB management plan.

Another externality can be realized when considering the overall economic impact of the entire citrus industry as opposed to the cumulative impacts on individual growers. If grower financial incentives are skewed entirely toward only being profitable in the next five to ten years, long term viability of the Florida citrus industry may be in jeopardy. The long-term implications of decisions growers make today will have long-term consequences on the volume of fruit production years from now. Harvesting companies, fruit haulers, and processing plants all depend on a sufficient volume of fruit to keep their enterprises economically viable. In addition, there are economic effects impacting the general economy. The Florida citrus industry contributes an estimated $9 billion to the state's economy (Hodges and Rahmani, 2009).

Market dynamics is another area where one needs to distinguish between individuals and the group. As individuals, growers have no effect on market prices for their fruit. If, on the other hand, growers make similar decisions with respect to production and disease management, their collective actions can shift the supply curve of fruit and thereby affect fruit prices. Figure 2 illustrates

Table 1. Economic factors and direction of their change in order to increase the likelihood that the financial returns from a tree removal program (R) will be greater than the financial returns from following an exclusive nutritional therapy program (N).

| Direction of change | Factor | Variable (Fig./Eq.) | The more likely that |
|---|---|---|---|
| The lower | Initial HLB infection rate | *A* (Fig. 1) | R > N |
| The lower | Long term control level | *T* (Fig. 1) | R > N |
| The shorter | Years to achieve control level | *Y* (Fig. 1) | R > N |
| The longer | Grower's planning horizon | *n* (Eq. 2) | R > N |
| The lower | Perceived risk | *i* (Eq. 2) | R > N |
| The lower | Expected long term fruit prices | *P* (Eq. 1) | R > N |
| The lower | Degree to which a nutritional program can maintain yields on infected trees | *Q* (Eq. 1) | R > N |
| The higher | Cost of nutritional materials | C (Eq. 1) | R > N |

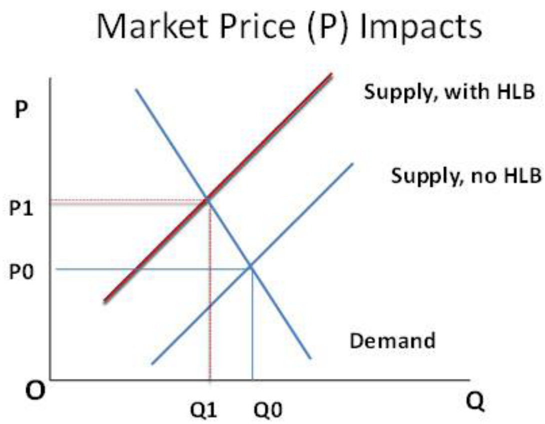


Fig 2. Market shifts in supply, quantity of fruit demanded, and prices paid for fruit.

a possible scenario in which a mandatory tree removal program reduces overall fruit production and consequently shifts the supply curve of fruit to the left. Since HLB has no direct effect on consumer demand for fruit (or juice), the shift in fruit supply moves along the existing demand curve and market prices rise from $P_0$ to $P_1$. For those growers not seriously impacted by HLB, higher prices could partially, if not completely, offset higher production costs. A higher fruit price, however, only offers a potential advantage when there is fruit to sell. For growers losing entire blocks from an eradication program, higher fruit prices offer little economic solace.

From an industry perspective, total industry revenues before HLB equal the area defined by $P_0 \times Q_0$ as shown in Fig. 2. With HLB and symptomatic tree eradication, the fruit supply curve shifts to the left. Prices rise from $P_0$ to $P_1$ and total fruit sold falls from $Q_0$ to $Q_1$. Total industry revenues change to $P_1 \times Q_1$. If demand for fruit is inelastic, meaning that fruit demand is not sensitive to price changes, then industry revenues with HLB ($P_1 \times Q_1$) will be greater than industry revenues prior to HLB ($P_0 \times Q_0$). Again, this interesting market dynamic is dependent on the inelastic demand for fruit and consumers not shifting away from fresh fruit or juice products if retail prices increase to offset the higher price of delivered-in fruit.

## Concluding Comments

More and more growers are moving away from tree eradication and toward nutritional therapies as a way to manage HLB. As growers and industry leaders learn more about HLB control strategies, there may come a point when there is a consensus opinion that deems a tree eradication program to be in the best interest of the entire citrus industry. If and when such an opinion is reached, public policies will have to be enacted that will constrain and limit actions of individual growers in order to follow the newly established public policy. How will such a policy be enforced and will there be financial compensation for growers who pull productive, yet infected, trees? If compensation is offered, who pays—citrus growers or the general public? To these questions, Florida citrus growers can learn from their Brazilian counterparts. The state government of Sao Paulo enacted a law requiring the removal of all HLB symptomatic trees. The law, however, has little or no effect. Public resources in Sao Paulo to ensure enforcement and/or provide growers with the appropriate economic incentives to comply with the law have not been put into place.

## Literature Cited

Dewdney, M.M. and J.H. Graham. 2009. Cooperative producers keep greening disease under control. Citrus Ind. Mag. 90(9):5–8.

Graham, J.H., T.R. Gottwald, J. Cubero, and D.S. Achor. 2004. *Xanthomonas axonopodis* pv. *citri*: Factors affecting successful eradication of citrus canker. Mol. Plant Pathol. 5:1–15.

Hodges, A. and M. Rahmani. 2009. Economic impacts of the Florida citrus industry 2007–08. University of Florida Electronic Data Info. System (EDIS), FE802. <http://edis.ifas.ufl.edu/fe802>.

Muraro, RP. 2010. Summary of 2009–2010 citrus budget for the Southwest Florida production region. Accessed 1 Mar. 2012. <http://www.crec.ifas.ufl/extension/economics>.

Tsai, J.H., J.J. Wang, and Y.-H. Liu. 2002 Seasonal abundance of the asian citrus psyllid *Diaphorina citri* (Homoptera: Psyllidae) in southern Florida. Florida Entomologist 85:446–451.