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Saving The Orange: How to Fight Citrus Greening Disease (And It's Not Through Genetic Engineering)

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SAVING THE ORANGE: HOW TO FIGHT CITRUS GREENING DISEASE (AND IT'S NOT THROUGH GENETIC ENGINEERING)

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INTRODUCTION

The orange is dying. With Florida's citrus industry already suffering from the growing skepticism of an increasingly health-conscious American public as to orange juice's benefits,[1] the emergence of citrus greening disease over the past two decades has left the orange's long-term future very much in doubt.[2]

A devastating virus first documented in China roughly one hundred years ago, citrus greening disease (or "HLB"), has only migrated to Florida in the past twenty years, but has quickly made up for lost time.[3]

Primarily transmitted by an insect known as the Asian citrus psyllid ("ACP"), the disease has devastated Florida growers in recent years, wiping out entire groves and significantly affecting trees' overall yield.[4] This past year, Florida growers experienced their least productive harvest in forty years, and current estimates of next year's yield are equally dismal.[5]

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[1] Adee Braun, *Misunderstanding Orange Juice as a Health Drink*, THE ATLANTIC (Feb. 6, 2014), http://www.theatlantic.com/health/archive/2014/02/misunderstanding-orange-juice-as-a-health-drink/283579/ [https://perma.cc/GH6R-97QE].

[2] Marina Koren, *The Mysterious Bacteria That's Killing Oranges and Jobs in Florida*, NAT'L JOURNAL (Sept. 4, 2014), http://www.nationaljournal.com/economy/the-mysterious-bacteria-that-s-killing-oranges-and-jobs-in-florida-20140904 [https://perma.cc/WE9X-TRSK].

[3] *History of Greening or Huanglongbing (HLB) Worldwide*, UNIV. OF FLA. IFAS, http://www.crec.ifas.ufl.edu/extension/greening/history.shtml [https://perma.cc/V7KC-5FQ3] (last visited Mar. 27, 2016).

[4] Koren, *supra* note 2.

[5] Kevin Bouffard, *Smallest orange crop in 50 years predicted*, DAILY COMMERCIAL (Aug. 16, 2014), http://www.dailycommercial.com/news/article_ad287da3-d707-5bab-a19f-572f2dfa0942.html [https://perma.cc/7XQ5-FTHT].

Meanwhile the threat posed by HLB shows no sign of dissipating as it continues to spread both throughout Florida and, more recently, into Texas and California.[6] The severity of the threat is compounded by the fact that there is currently no means through which to treat a citrus tree once infected, nor have any strains of oranges shown resistance to the disease.[7]

So, what then can be done to stop the orange from diminishing to the point of extinction? Growers have naturally attempted every method at their disposal, from removing infected trees to growing trees in enclosed nurseries,[8] but have thus far experienced only limited success.

These measures merely seek to manage an epidemic which has long since reached its crisis point, and by themselves are unlikely to ensure the orange's long-term viability. However, studies conducted on a trial basis in the past few years point to a possible way forward through the use of genetic engineering.[9]

Of particular interest is a study conducted by a Texas A&M researcher in which he cross-bred spinach genes with those from an orange, as the resulting hybrid proved resistant to disease-carrying ACPs.[10] Understandably, this has led to a great deal of excitement from not only the research community and citrus industry, but also numerous media outlets, who have seized on this experimental method as the orange's savior.[11]

But while genetic engineering may ultimately provide farmers with the best tool for combating citrus greening disease, focusing on it at the expense of other, more viable short-term options is a strategy that is doomed to fail due to the complexity of the genetically modified organism ("GMO") regulatory process.

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[6] Dan Santella, *Citrus greening quarantine set north of Donna*, THE MONITOR (Feb. 5, 2014), http://www.themonitor.com/news/local/citrus-greening-quarantine-set-north-of-donna/article_5672a9d4-8ed6-11e3-8860-0017a43b2370.html [https://perma.cc/DTX2-ZSWM].
[7] E. Stover et al., *Breeding Citrus for HLB Resistance at the USDA/ARS U.S. Horticultural Research Laboratory*, CAL. CITRUS QUALITY COUNCIL, http://calcitrusquality.org/wp-content/uploads/2009/05/Stover-Breeding-for-HLB-resistance.pdf [https://perma.cc/2YAQ-8QU2] (last visited Mar. 27, 2016).
[8] Barrett Gruber et al., *Fertilization and irrigation effects on the growth of potted citrus nursery trees*, CITRUS RESEARCH DEV. FOUND. (Sept. 2015), http://www.crec.ifas.ufl.edu/extension/trade_journals/2013/2013_September_Potted.pdf [https://perma.cc/U2PT-JAV3].
[9] Amy Harmon, *A Race to Save the Orange by Altering Its DNA*, N.Y. TIMES (July 27, 2013), http://www.nytimes.com/2013/07/28/science/a-race-to-save-the-orange-by-altering-its-dna.html?pagewanted=all&_r=2& [https://perma.cc/6CQS-GMN5].
[10] *Id.*
[11] *Id.*

The regulatory channels through which GMO foods are approved are notoriously slow to navigate,[12] a matter that is not helped by the American public's resistance to unnatural cuisine and the resulting pressure on agencies such as the United States Department of Agriculture ("USDA") and the United States Food and Drug Administration ("FDA") to retard the process even further.[13]

In the meantime, it is vital to focus on solutions that can have an immediate impact such as federal and state funding for the removal and replacement of infected orange trees.[14] This can be accomplished both through securing additional funding from the USDA's Tree Assistance program,[15] which makes payments for lost trees that produce annual crops, and through instituting a modified form of the controversial eradication program Florida used in the past to combat citrus canker.[16]

While these may be short-term solutions, they are also necessary to ensure the orange's survival. People must not lose sight of the fact that citrus greening disease is not a hypothetical exercise, but is in fact inflicting massive economic losses both on the citrus industry and the countless people it benefits. If there is any hope of keeping the disease at bay, action must be taken now.

Part I of this Note will contain general background information on citrus greening disease: what it is, when it was first encountered, the extent of its distribution, and why it currently poses such a severe threat to the future of the citrus industry.

Part II will delve into the history of citrus canker, a disease against which Florida citrus growers have been fighting for the past century, providing some necessary context with which to evaluate the current crisis. Focus is given to Florida's citrus canker eradication program and the various legal headaches it has caused for state officials.

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[12] Paul Voosen, *Can Genetic Engineering Save the Florida Orange?*, NAT'L GEOGRAPHIC (Sept. 13, 2014, 8:08 PM), http://news.nationalgeographic.com/news/2014/09/140914-florida-orange-citrus-greening-gmo-environment-science/ [https://perma.cc/7BM5-LQLN].

[13] Kimberly Wilmoth, *UF study shows Floridians are concerned about food safety*, UNIV. OF FLA. (Dec. 3, 2013), http://news.ufl.edu/archive/2013/12/food-safety-is-among-top-concerns-for-floridians-ufifas-survey-finds.html [https://perma.cc/M2VU-6N6S].

[14] *Tree Assistance Program Fact Sheet*, FSA, http://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/2015/tap_fact_sheet_oct_2015.pdf https://perma.cc/X53A-6ZEG] (last visited Mar. 27, 2016).

[15] *Id.*

[16] Ben Wolford, *Citrus canker lawsuit headed back to trial*, SUN SENTINEL (Oct. 16, 2013), http://articles.sun-sentinel.com/2013-10-16/news/fl-citrus-canker-ruling-20131016_1_canker-healthy-citrus-tree-orange-trees [https://perma.cc/V72P-B3RM].

Part III will be split up into two parts, with the first evaluating present management practices for containing the effects of HLB and the second discussing proposed options for better combating it in the future. In particular, genetic modification will be highlighted given the extent to which it has met with favor in the scientific and journalistic communities.

But while the Note acknowledges the potential benefits of genetic engineering and its value to the orange's long-term survival, it also outlines the limitations to this approach and questions whether there are superior lines of attack at present.

Part IV will discuss some alternative options, such as utilizing funding from the tree removal program and implementing a citrus greening eradication program, that while perhaps not revolutionary are nonetheless essential. The Note concludes that HLB is unlike any threat that Florida's citrus industry has faced before, and that only a combination of approaches has any hope of halting its deadly progress.

I. HISTORY OF CITRUS GREENING DISEASE

Citrus greening disease (also referred to as HLB or yellow dragon disease) is a disease of citrus caused by the bacteria, *Candidatus Liberibacter*, which is then transmitted by one of two insects: the Asian citrus psyllid (*Diaphorina citri*) and the African citrus psyllid (*Trioza erytreae*).[17] Thus far only the Asian citrus psyllid has been discovered in the United States.[18] First reported in southern China in 1919, HLB has also been documented in various parts of Asia and South Africa.[19]

However, it was not until 1956 that the nature of this disease was first understood when Lin Kung Hsiang, a Chinese researcher, determined that HLB was a "graft transmissible infectious disease" and did not stem from nutrient or soil deficiencies.[20]

The African and Asian citrus psyllids were shortly afterwards identified as "vectors" of the disease, although neither was encountered in North America prior to the discovery of the ACP in Florida in 1998.[21] By 2005, symptoms of HLB had been observed throughout southeastern

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[17] *Asian Citrus Psyllid*, UNIV. OF FLA. IFAS, http://entomology.ifas.ufl.edu/creatures/citrus/acpsyllid.htm#disease [https://perma.cc/A2NE-Y57U] (last visited Mar. 27, 2016).
[18] *Id.*
[19] *History of Greening or Huanglongbing (HLB) Worldwide*, *supra* note 3.
[20] *Id.*
[21] R.H. Brlansky et al., *2014 Florida Citrus Pest Management Guide*, UNIV. OF FLA. IFAS, http://edis.ifas.ufl.edu/cg086 [https://perma.cc/SZ6H-F7CF] (last visited Mar. 27, 2016).

Florida,[22] and would only continue to spread throughout the state's commercial citrus growing areas in the coming years.

HLB-related symptoms have now been reported in all thirty-four Florida counties in which citrus is commercially produced.[23] In all, there are thought to be as many as 100 million trees worldwide that have been infected with HLB, with instances being confirmed in California, Texas, and Brazil in the past decade. Currently there are no known citrus species, varieties or combinations that are immune.[24]

A. Conditions Leading to Infestation

How the disease-carrying insects first entered Florida is not definitively known, however Florida's geography is thought to play a significant role.[25] The state is undoubtedly disadvantaged by its 1,350 miles of coastline that provides countless entry points for insects arriving both via air and in the company of humans returning from vacations in tropical locales.[26] Additionally, Florida contains an estimated population of 19.9 million,[27] which creates a sizable market for agricultural produce shipped from around the world.

While agencies such as the USDA have attempted to maintain robust surveillance efforts of Florida's various ports, they nevertheless remain key avenues through which insects are able to gain entry to the state.[28] Upon arrival, these insects are easily transferred by way of seeds, foliage, and soil and are thus able to wreak havoc on the state's agriculture.[29]

Finally, Florida's warm weather and perennial vegetation has contributed to a higher population of insects and has led to more frequent

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[22] *Id.*
[23] NAT'L RESEARCH COUNCIL, STRATEGIC PLANNING FOR THE FLORIDA CITRUS INDUSTRY 1 (2010), *available at* http://www.nap.edu/read/12880/chapter/4#37 [https://perma.cc/Z4S4-PPT5] (last visited Mar. 27, 2016).
[24] *Id.* at 4.
[25] *Id.* at 23.
[26] *Id.*
[27] *Quick Facts*: *Florida*, U.S. CENSUS BUREAU, http://quickfacts.census.gov/qfd/states/12000.html [https://perma.cc/B6BP-Q6FJ] (last visited Mar. 27, 2016).
[28] *Non-Native Invasive Plants—An Introduction*, UNIV. OF FLA. IFAS, http://plants.ifas.ufl.edu/manage/why-manage-plants/non-native-invasive-plants-an-introduction [https://perma.cc/D37A-HCR7] (last visited Mar. 27, 2016).
[29] *Id.*

application of insecticides.[30] This has predictably resulted in insecticide resistant insects,[31] which have then been able to travel long distances due to the frequency of hurricanes and summer thunderstorms in Florida.

B. Transmission and Symptoms of Disease

HLB's transmission cycle generally consists of the ACP acquiring the pathogen after feeding on a diseased plant, which it then retains after a brief incubation period.[32] However, the process of transmission is still poorly understood and research is being done to decipher its various stages.[33]

For example, there is considerable disagreement as to the length of the latency period (the amount of time it takes the insect to inoculate the pathogen), with estimates varying from eight to twenty-five days.[34] What is known is that after the pathogen is acquired, it multiplies in the insect, which thereafter remains infected for life.[35]

The initial period of infection in citrus trees can be recognized by the appearance of characteristic "yellow shoots," which eventually grow into bigger yellow/green branches.[36] In later stages of the disease, the yellow branches take over the whole canopy, indicating that the tree is fully infected.[37]

Affected branches may show one or several of the following features: defoliation, mottled leaves, mineral deficiency, or consistently yellow-colored fruits, "which have a tendency to drop."[38] Defoliation is particularly damaging as it often leads to thin vegetation and "open" growth.[39]

However, "blotchy" mottle leaves are likely HLB's most characteristic symptom as they have become synonymous with the disease and

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[30] Joe Wolf, *The Overuse and Misuse of Pesticides*, UNIV. OF LAF. IFAS, http://polkmastergardener.ifas.ufl.edu/Articles/Overuse%20of%20Pesticides%202.pdf [https://perma.cc/7EWB-HX2E] (last visited Mar. 27, 2016).
[31] *Id.*
[32] *Asian Citrus Psyllid*, *supra* note 17.
[33] NAT'L RESEARCH COUNCIL, *supra* note 23, at 36.
[34] *Id.*
[35] *Asian Citrus Psyllid*, *supra* note 17.
[36] *Citrus Diseases: Huanglongbing (HLB)*, CITRUS RESOURCE, http://idtools.org/id/citrus/diseases/factsheet.php?name=Huanglongbing+%28HLB%29 [https://perma.cc/2UHU-EAWG] (last visited Mar. 27, 2016).
[37] NAT'L RESEARCH COUNCIL, *supra* note 23, at 37.
[38] *Id.*
[39] *Id.*

accompany it wherever it occurs in the world.[40] Leaves with blotchy mottle have several shades of yellow, pale green and dark green that blend into each other,[41] and because there are no clearly defined boundaries between them, blotchy mottle has come to be used as a descriptive term.

In the early stages of HLB, blotchy mottle is sometimes the only leaf symptom that can be seen.[42] In later stages, signs of mineral deficiency typically develop, resulting in smaller-sized leaves, and in some instances causing the entire leaf blade to turn yellow.[43]

HLB also produces distinguishing symptoms on fruit, which are easily seen on sweet oranges but are also observed in many other species and varieties.[44] Fruits affected by HLB exhibit orange-tinged "vascular bundles," are lopsided and undersized compared to normal fruit, and have "aborted seeds."[45]

Juice obtained from oranges demonstrating these symptoms is comparable to that of immature fruit while HLB-infected trees are prone to high amounts of dropped fruit, significantly impacting their overall yield.[46]

C. Impact of HLB

HLB represents the most significant threat the Florida citrus industry has ever faced and threatens the long-term viability of the industry. When taking into account the various economic direct and indirect benefits resulting from citrus production, the Florida citrus industry was credited with approximately $9 billion in total economic impact in 2012.[47]

In a five year period between 2006 and 2011, HLB cost the state 8,257 jobs and $4.5 billion in lost revenue, a University of Florida Institute of Food and Agricultural Sciences study found.[48] After factoring in

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[40] *Citrus Diseases: Huanglongbing (HLB)*, *supra* note 36.
[41] *Id.*
[42] NAT'L RESEARCH COUNCIL, *supra* note 23, at 38.
[43] *Id.*
[44] *Id.* at 39.
[45] *Id.*
[46] Timothy M. Spann & Michelle D. Danyluk, *Effects of HLB infection on sweet orange fruit size and quality*, CITRUS INDUS., Sept. 2010, at 15, *available at* http://www.crec.ifas.ufl.edu/extension/trade_journals/2010/2010_Sept_effects_hlb.pdf [https://perma.cc/MZU4-9YAX].
[47] *Citrus Statistics*, FLA. CITRUS MUT., http://flcitrusmutual.com/citrus-101/citrusstatistics.aspx [https://perma.cc/QCZ3-Z5CB] (last visited Mar. 27, 2016).
[48] Evan Williams, *Citrus Industry in Jeopardy*, FLA. WEEKLY (Jan. 1, 2014), http://fort

indirect costs and labor income, that figure is more than $9 billion lost—essentially the state's entire yearly revenue from citrus.[49]

Moreover, HLB's growth shows no indication of letting up; in fact, within the next few years the disease could potentially eliminate over three-quarters of Florida's citrus crop and many of the industry's 75,000 jobs if a solution is not found.[50]

Since 2008, a number of growers have noticed a considerable decline in yield as a result of HLB, a perception that coincides with available data.[51] According to the USDA's records Florida has almost 200,000 fewer citrus-bearing acres than it did in 2004.[52] In that same time the state has lost nearly 18 million orange trees, mostly due to HLB.[53]

Historically, citrus trees last thirty to forty years, but with HLB their productive life could be reduced to, at most, ten to twenty years, making it difficult to break even on total costs.[54] And as the majority of Florida's adult citrus trees are now thought to be infected with HLB, those within the industry believe that at the current rate the species will be extinct within ten years.[55]

The immediate effects of yield shortages are less certain, however, it has been established that young citrus trees infected with HLB will never provide commercially viable fruit.[56] Meanwhile, the rate at which mature trees deteriorate is dependent on the extent of the infection that has taken place.[57]

If numerous infections befall a tree within a short span of time, it may not bear fruit for more than another five years.[58] Regardless of

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myers.floridaweekly.com/news/2014-01-15/Business_News/Citrus_industry_in_jeopardy.html [https://perma.cc/D94D-BUDY].

[49] *Id.*

[50] Koren, *supra* note 2.

[51] Williams, *supra* note 48.

[52] *Id.*

[53] *Id.*

[54] Evan Williams, *Crushed Oranges*, FLA. WEEKLY (Oct. 29, 2014), http://fortmyers.floridaweekly.com/news/2014-10-29/Top_News/CRUSHED_ORANGES.html [https://perma.cc/5CZB-RAEM].

[55] CITRUS RESEARCH AND DEVELOPMENT FOUNDATION, GROWER RESEARCH REPORT 1 (Jan. 2015), *available at* http://citrusrdf.org/wp-content/uploads/2015/02/CRDF-Volume-4-Issue-5-January.pdf [https://perma.cc/5CY5-KXY4].

[56] Brlansky et al., *supra* note 21.

[57] *Id.*

[58] Asian Citrus Psyllid & Huanglongbing Disease, UC DAVIS IPM, http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74155.html [https://perma.cc/F5FE-ZB9S] (last visited Mar. 27, 2016).

individual circumstances, the life spans of citrus groves are likely to diminish with each passing year.[59]

Reduced yield has had a predictable impact on commercial production. Last year, Florida produced a mere 104.4 million boxes of oranges, a nearly three-decade low.[60] Unfortunately, citrus consultants expect that trend to continue, with current predictions for the 2014–15 season ranging from 89–96.6 million boxes.[61] An amount at the lower end of this spectrum would constitute the smallest orange crop in fifty years.[62]

While initial forecasts for the 2014–15 season indicate that such a pessimistic assessment was unwarranted,[63] most agree that a yield this low would make it very challenging for most growers to turn a profit given how high production costs have risen in the course of instituting HLB-prevention measures.[64] These conditions could also result in the Florida citrus industry further contracting, including the closure of juice processing plants and growers no longer able to make a living.[65]

Additionally, since HLB appeared in Florida the price of non-concentrate orange juice has quickly risen from $5 to $7 per gallon.[66] This development concerns some analysts who say that consumers are already "revolting against that price."[67] One expert projected that the price for early and mid-season oranges will increase to $2 per pound, a 7% increase, while that for Valencia oranges could rise to more than $2.44 per pound.[68]

Meanwhile, farmers are doing everything in their power to stem the tide of HLB. Focused applications of pesticides, such as the widely used Boyd method, have had success in diminishing the ACP population and in expanding the life spans of trees.[69] But even with these results, it

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[59] *Id.*
[60] Marvin G. Perez, *Orange Juice Falls to Six-Month Low Amid 'Dismal' U.S. Demand*, BLOOMBERG (July 31, 2014), http://www.bloomberg.com/news/articles/2014-07-31/orange-juice-falls-to-six-month-low-amid-dismal-u-s-demand [https://perma.cc/6AFB-5B9B].
[61] Bouffard, *supra* note 5.
[62] *Id.*
[63] Heather McPherson, *USDA Monthly Forecast for 2014–15 orange crop still at 108 million boxes*, ORLANDO SENTINEL (Dec. 10, 2014, 4:49 PM), http://www.orlandosentinel.com/features/food/os-usda-forecast-orange-crop-108-million-boxes-post.html [https://perma.cc/HZ4S-YMQ2].
[64] Bouffard, *supra* note 5.
[65] *Id.*
[66] Williams, *supra* note 48.
[67] *Id.*
[68] Bouffard, *supra* note 5.
[69] Joe Satran, *Citrus Greening Forces Florida Growers to Trust A Controversial Savior*,

is unknown how long growers can maintain an HLB-infected tree with these methods before it becomes economically unfeasible.[70] The Boyd Method alone has nearly doubled the cost per acre of citrus production from what it was in 2006.[71]

In short, HLB has proven to be a very costly disease. Industry experts largely agree that HLB-related symptoms are responsible for the majority of Florida's decrease in citrus production over the past decade.[72] Equally concerning is the fact that HLB has rendered symptomatic trees more vulnerable to a whole host of other diseases, not least of which is citrus canker.[73]

II. LESSONS FROM CITRUS CANKER

Citrus canker is a citrus-targeting disease whose trademark is the formation of lesions on the leaves, stems, and fruit of affected trees.[74] Unlike HLB-infested oranges, fruit infected with canker is harmless to humans; however, their unpleasant appearance makes them impossible to sell and has resulted in major economic losses for the citrus industry.[75]

First introduced in Florida in 1910, the disease thereafter spread along the Gulf Coast, encompassing states as far away as Texas and South Carolina.[76] Following the establishment of a quarantine in 1915 an eradication program was put in place, leading to citrus canker's apparent elimination in 1933.[77]

However, a second outbreak followed in 1986 after the disease was spotted on a number of citrus trees in Florida's Tampa Bay region.[78] This outbreak lasted until 1994 when citrus canker was again said to be eradicated.[79]

HUFFINGTON POST (Sept. 30, 2013, 7:37 AM), http://www.huffingtonpost.com/2013/08/30/citrus-greening_n_3780984.html [https://perma.cc/BX5S-GJNV].

[70] *Id.*

[71] *Id.*

[72] Williams, *supra* note 54.

[73] *Id.*

[74] M.M. Dewdney et al., *Homeowner Fact Sheet: Citrus Canker*, UNIV. OF FLA., http://edis.ifas.ufl.edu/pp116 [https://perma.cc/MJ53-YCPA] (last visited Mar. 27, 2016).

[75] *Id.*

[76] *Id.*

[77] *Id.*

[78] *Id.*

[79] *Id.*

Yet only a year later citrus canker was found on a residential tree in Miami-Dade County, after which a mandatory eradication program was implemented by the Florida Department of Agriculture ("Department").[80] At first, this consisted of eliminating all citrus trees that were within 125 feet of infected plants.[81]

Unfortunately, this policy proved to be overly conservative and ultimately had little impact on the prevalence of citrus canker. This resulted in the Department overseeing a series of studies that considered how the eradication program might be improved upon.[82]

Based upon these studies the Citrus Canker Technical Advisory Task Force, a group of regulators, scientists, and citrus industry spokespersons, recommended that the eradication zone be extended to a 1,900-foot radius.[83] Shortly thereafter the Department adopted the group's recommendations, with the 1,900-foot zone becoming effective as of 2000.[84] Additionally, Section 581.184, Florida Statutes was amended to compel the State to eliminate "all citrus trees exposed to infection."[85]

Within two years more than 1.56 million commercial trees and nearly 600,000 residential trees were removed or cut back under this policy.[86] However, by 2006 the eradication program was discontinued following a statement by USDA officials that that they would no longer fund eradication-focused tree removal.[87]

Given that the USDA had supplied a large amount of the funding for the eradication program and the entirety of that for grower compensation, state officials felt that implementation of the eradication zone was no longer financially feasible.[88]

The change in policy came after a review of scientific research indicated that Hurricane Wilma, which landed in Florida in 2005, had

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[80] DAVID LOWE, CURRENT SITUATION, MANAGEMENT AND ECONOMIC IMPACT OF CITRUS CANKER IN FLORIDA, *available at* http://www.calcitrusquality.org/wp-content/uploads/2009/05/current-situation2.pdf [https://perma.cc/L78K-HN6G] (last visited Mar. 27, 2016).
[81] *Id.*
[82] *Id.*
[83] Haire v. Fla. Dep't of Agric. & Consumer Servs., 870 So. 2d 774, 779 (Fla. 2004).
[84] *Id.*
[85] FLA. STAT. § 581.184 (2002).
[86] Tim R. Gottwald et al., *Citrus Canker: the Pathogen and Its Impact*, AM. PHYTOPATHOLOGICAL SOC'Y (July 17, 2002), http://www.apsnet.org/publications/apsnetfeatures/Pages/citruscanker.aspx [https://perma.cc/DNJ8-6W8T].
[87] Liz Compton, *USDA Determines Citrus Canker Eradication Not Feasible*, UNIV. OF FLA. IFAS (Jan. 11, 2006), http://nassau.ifas.ufl.edu/news/citruscanker.html [https://perma.cc/3LYD-H4JT].
[88] *Id.*

potentially spread citrus canker to as many as 220,000 acres of commercial citrus.[89] When taken in conjunction with the 80,000 acres of commercial citrus impacted by hurricanes from the previous year,[90] it is easy to see why the USDA would question the efficacy of the eradication program.

Also affecting the USDA decision was the fact that growers had disclosed they would be unable to withstand the loss of further citrus acreage and that the cost of realizing the program would greatly outweigh the annual $36 million allotment.[91] This was largely due to the hundreds of millions of dollars that would be needed to adequately compensate growers for losses they suffered in the course of the policy's implementation.[92]

This last point has proven particularly prescient as in the wake of the eradication program five Florida counties filed class-action lawsuits against the state, including Palm Beach, Broward, Miami-Dade, Lee, and Orange.[93]

Homeowners argued that the trees they lost as a result of the program had been significantly undervalued and were offended by the state's offer of Walmart cards and $55 cash payments.[94] Palm Beach and Broward County residents sought the greatest amount of compensation, claiming losses of 66,493 and 133,720 citrus trees, respectively.[95]

To date, only the Broward County case has been settled, with the jury ultimately awarding the plaintiffs a $34-per-tree payment for a total of $4.5 million.[96] However, a series of state appellate and Supreme Court rulings over the past ten years have firmly established the right of homeowners to compensation for healthy citrus trees removed under the eradication program.

In *Haire v. Florida Department of Agriculture & Consumer Services*, the Court concluded that while Florida's legislature set a compensational floor for losses incurred under the eradication program, it did not determine the amount of compensation.[97] It also held that the Legislature's

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[89] *Id.*
[90] *Id.*
[91] *Id.*
[92] *Id.*
[93] Ben Wolford, *Citrus Canker Lawsuit Headed to Trial*, SUN SENTINEL (Oct. 16, 2013), http://articles.sun-sentinel.com/2013-10-16/news/fl-citrus-canker-ruling-20131016_1_canker-healthy-citrus-tree-orange-trees [https://perma.cc/38GR-8HSL].
[94] *Id.*
[95] *Id.*
[96] *Id.*
[97] *Haire*, 870 So. 2d at 785.

establishment of the 1,900-foot eradication zone did not "necessarily support a finding that healthy . . . residential citrus trees have no value."[98]

Department of Agriculture and Consumer Services v. Bogorff built upon this decision, with the Court holding not only that the citrus trees' removal amounted to a "compensable taking," but that the assessment of damages should be based on the cost of replacing the removed trees.[99] Previously it had been determined by the decrease in value of the real estate from which the trees were taken.[100]

Finally, in *Florida Department of Agriculture & Consumer Services v. Mendez*, the Court held that while a state agency has inherent police powers that it may exercise in seeking to prevent a public harm, this "did not apply to preclude compensation for the destroyed trees."[101] However, it conceded that scientific evidence as to the dangers of citrus canker may be considered when determining the value of destroyed trees.[102]

Unsurprisingly, Florida has yet to implement a similar program for HLB, meaning that with regards to managing the disease, citrus growers are largely on their own.

III. DISEASE MANAGEMENT PRACTICES

A. Current Methods

In Florida, three methods are presently recommended for treating HLB-infected trees: (1) removing infected trees, (2) applying insecticide to minimize ACP populations, and (3) growing healthy citrus trees in sealed, insect-proof nurseries prior to planting them in new orchards.[103]

There are essentially two approaches to removing HLB-infected trees: (1) immediately replace them with young trees or (2) allow them to infect the other trees in their grove and then remove all of them when orange production is no longer feasible.[104] Experts generally believe that in reality the economic difference between these two scenarios is negligible and that the most desirable approach depends on the situation.[105]

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[98] *Id.*
[99] Fla. Dep't of Agric. & Consumer Servs. v. Bogorff, 35 So.3d 84, 91 (Fla. Dist. Ct. App. 2010).
[100] *Id.*
[101] Fla. Dep't of Agric. & Consumer Servs. v. Mendez, 126 So. 3d 367, 374 (Fla. Dist. Ct. App. 2013).
[102] *Id.* at 376.
[103] NAT'L RESEARCH COUNCIL, *supra* note 23, at 50.
[104] *Id.* at 57.
[105] *Id.* at 58.

From an operational standpoint, it might be simpler to adopt the second method so as to avoid having to continually replant new trees.[106] However that would entail leaving in place large numbers of HLB-infected trees, which could quickly contaminate nearby healthy stock.[107] Thus, it is considered advisable to remove infected trees promptly and then follow suit with the remainder of the block when too few trees remain to be economically viable.[108]

B. Proposed Method (Genetic Engineering)

But while management strategies such as tree replacement and insecticide spraying may be effective in certain situations they are at best short-term solutions and cannot be relied upon to ensure the orange's long-term survival. It is not enough to respond quickly to instances of HLB. Research must be centered on preventing its occurrence in the first place, otherwise the disease will continue to outpace all efforts to contain it.

To this end, scientists have experimented in recent years with various techniques designed to protect the orange from the ACP.[109] As a result of these experiments an increasing number of scientists have concluded that genetic engineering contains the key to the orange's future. Given the absence of any strains of orange that are naturally immune to HLB, proponents of the technology claim that the only hope of saving the fruit is through alteration of its DNA.[110]

In support of their contention, these advocates cite the various ways in which genetic engineering might improve the quality of the world's crops such as by increasing their nutritional value or their resistance to pests.[111] They also state that despite being subjected to intense scrutiny it has repeatedly been determined that GMOs are safe for human consumption, a byproduct of the rigorous testing they undergo.[112]

Furthermore they insist that even if genetic engineering were to somehow disappear, food would still be modified in any number of ways,

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[106] *Id.*
[107] *Id.*
[108] *Id.*
[109] Voosen, *supra* note 12.
[110] *Id.*
[111] Asis Datta, *Genetic Engineering for Improving Quality and Productivity of Crops*, AGRIC. & FOOD SECURITY (Nov. 30, 2013), *available at* http://www.agricultureandfoodsecurity.com/content/2/1/15 [https://perma.cc/F36U-V7EZ].
[112] *Id.*

none of which is without risk.[113] It has even been argued that genetic engineering is safer than these other methods given that each gene added in the course of its process has a clear function as opposed to the random mutations that occur during traditional crossbreeding.[114]

Finally, while proponents of genetic engineering admit that it might be preferable for the orange to naturally evolve resistance to the *C. liberibacter* bacteria, such a process could take years while in the meantime the orange withers and dies.[115] Some scientists believe that consumers would sooner accept genetically modified oranges than risk this possibility.[116]

And in truth there is some indication that consumers are less resistant to genetically engineered oranges than other GMOs, particularly if the alternative is the orange's extinction.[117] Furthermore, trials of citrus trees spliced with a spinach gene have proven promising thus far, showing no symptoms of HLB despite being placed in infected greenhouses for over a year.[118]

C. Disadvantages

1. Regulatory Process

However, the genetic modification route is not free of drawbacks and in fact there are a number of reasons why caution should be exercised before christening it the orange's savior. The GMO regulatory process in the United States is often said to be comparatively light to that in other countries,[119] and is felt by some to be overly deferential to developers.

While this may be true to an extent, GMOs must nevertheless pass through multiple levels of regulation to ensure their safety to the public.[120] According to an industry-sponsored study, large companies spend an average of $35 million on regulatory costs alone.[121]

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[113] Kerryn Sakko, *The Debate Over Genetically Modified Foods*, ACTIONBIOSCIENCE (May 2002), http://www.actionbioscience.org/biotechnology/sakko.html [https://perma.cc/ZE7F-SAZM].
[114] *Id.*
[115] Harmon, *supra* note 9.
[116] *Id.*
[117] *Id.*
[118] Voosen, *supra* note 12.
[119] *Restrictions on Genetically Modified Organisms: United States*, LIBRARY OF CONG., http://www.loc.gov/law/help/restrictions-on-gmos/usa.php [https://perma.cc/NY28-3RMD] (last updated June 9, 2015).
[120] *Id.*
[121] Andrew Pollack, *By 'Editing' Plant Genes Companies Avoid Regulation*, N.Y. TIMES

In order to be sanctioned for commercial use, a GMO must first be evaluated by the Animal and Plant Health Inspection Service ("APHIS"), an agency of the USDA that determines whether a plant will become a pest.[122] It may also be necessary to receive feedback from the FDA and the United States Environmental Protection Agency ("EPA") depending on the GMO's intended use.[123]

As would be expected, the EPA reviews GMOs that are potentially hazardous to the environment,[124] while the FDA regulates the "safety of food for humans and animals, including foods produced from genetically engineered ("GE") plants."[125] Clearly a genetically modified orange would fall under this category.

But while it may not be mandatory to subject oneself to all three of these regulatory channels, many GMO producers choose to do so given the obvious benefits in receiving their stamp of approval.[126] However, this takes time since in rendering their decisions these agencies consult numerous laws governing the safety of GMOs, including the Plant Protection Act (USDA) and the Federal Food, Drug, and the Cosmetic Act (FDA and EPA).[127]

The result of this intensive review process is that a large number of GMOs never make it to the other side, even those with considerable health benefits.[128] This is particularly the case for projects that require the approval of synthetic genes as the necessity of proving their safety would only attract closer scrutiny.[129] Understandably this has led to a high degree of caution in the development of GMO-based solutions.

(Jan. 1, 2015), http://www.nytimes.com/2015/01/02/business/energy-environment/a-gray-area-in-regulation-of-genetically-modified-crops.html [https://perma.cc/UHR6-CWB2].

[122] *Restrictions on Genetically Modified Organisms: United States*, *supra* note 119.

[123] *Id.*

[124] *EPA's Regulation of Biotechnology for Use in Pest Management*, ENVTL. PROT. AGENCY, http://www.epa.gov/regulation-biotechnology-under-tsca-and-fifra/epas-regulation-biotechnology-use-pest-management [https://perma.cc/VGR2-78X6] (last updated March 11, 2016).

[125] *Questions and Answers on Food from Genetically Engineered Plants*, FOOD & DRUG ADMIN., http://www.fda.gov/Food/FoodScienceResearch/GEPlants/ [https://perma.cc/3CXA-PF3B] (last updated Nov. 11, 2015).

[126] Alan McHughen & Stuart Smyth, *US regulatory system for genetically modified crop cultivars*, 6 PLANT BIOTECHNOLOGY J. 2, 4 (2007).

[127] *Id.* at 5, 7, 11.

[128] Jeff Schweers, *Genetically modified foods face hurdles*, GAINESVILLE SUN, http://www.gainesville.com/article/20140629/ARTICLES/140629633 [https://perma.cc/8R4R-DE87] (last modified June 29, 2014, 4:48 PM).

[129] Harmon, *supra* note 9.

Even under the best of circumstances, the road to fruition is a long one as it can take several years before transgenic trees are strong enough to be planted in the ground and even longer before they are capable of bearing fruit.[130] This is particularly the case for genes that have shown promise when tested in other plants but have yet to be transferred to citrus trees.[131] Needless to say, better short-term options are required.

Unfortunately some of the most successful experiments are merely stopgap measures, such as one scientist's efforts to modify citrus trees by injecting a gene through an opening in the bark.[132] While temporarily effective, genes transferred in this manner would ultimately cease to function and so obviously could not be depended upon as a long-term solution.[133]

And then there is the matter of consumer skepticism, which would render moot any of the above-mentioned issues.

2. Consumer Resistance

Despite indications that the general public might be more receptive to genetically modified oranges than other genetically modified foods, there are still many who are deeply opposed to the concept.[134] Because genetic engineering typically involves combining the DNA of different species it raises concerns that we are meddling in areas we do not fully understand, particularly given the rapidity with which the technology has expanded.[135]

Critics contend that such crops carry unknown risks and are especially wary of the giant agrochemical companies such as Monsanto that produce them on a large scale.[136] These concerns are reflected in the views of many environmentalists and organic food organizations and have increasingly been adopted by consumers as well.[137] A byproduct of this has been a growing number of calls for mandatory labeling of GMO food products.[138]

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[130] Voosen, *supra* note 12.
[131] *Id.*
[132] *Id.*
[133] *Id.*
[134] Mickie Anderson, *Survey shows Floridians have concerns about food safety, GMOs*, UNIV. OF FLA (Dec. 8, 2014), http://news.ufl.edu/archive/2014/12/survey-shows-floridians-have-concerns-about-food-safety-gmos.html [https://perma.cc/N8CL-GPXE].
[135] *Id.*
[136] Schweers, *supra* note 128.
[137] *Id.*
[138] Amy Harmon & Andrew Pollack, *Battle Brewing Over Labeling of Genetically Modified*

While a California ballot measure on this issue was defeated at the polls, it has led to related proposals in other states such as Washington, Connecticut, and Vermont, demonstrating the strength of the opposition.[139] This has resulted in increased time spent on public awareness campaigns and has made it more difficult to obtain funding from private investors for genetic engineering research.[140]

According to recent polls, more than half of Americans believe genetically modified foods are unsafe to eat,[141] while ninety-three percent think GMO labeling should be mandatory.[142] Some studies have suggested that attitudes toward GMOs will gradually shift as consumers become better informed of their benefits and more accustomed to their presence in supermarkets.[143] That may one day be the case, but it clearly does not reflect current attitudes.

As it stands any GMO-related solution is likely to be a difficult sale for skeptical consumers. While it is true that Americans have long eaten genetically modified foods this has largely been in the form of hidden ingredients that they were not even aware of.[144] And of the few GMOs that have found their way to the produce section, none can claim to share the orange's iconic status.

IV. A BETTER FRAMEWORK

A. USDA Tree Assistance Program and HLB MAC Groups

As stated earlier, genetic engineering could ultimately play a significant role in the orange's revitalization. But so long as obstacles

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Food, N.Y. TIMES (May 24, 2012), http://www.nytimes.com/2012/05/25/science/dispute-over-labeling-of-genetically-modified-food.html [https://perma.cc/MY8B-UEKV].

[139] *Id.*

[140] Schweers, *supra* note 128.

[141] Cary Funk & Lee Raine, *Public and Scientists' Views on Science and Society*, PEW RESEARCH CENTER (Jan. 29, 2015), http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/ [https://perma.cc/AP2A-GK2Y].

[142] Allison Kopicki, *Strong Support for Labeling Genetically Modified Foods*, N.Y. TIMES (July 27, 2013), http://www.nytimes.com/2013/07/28/science/strong-support-for-labeling-modified-foods.html?_r=0 [https://perma.cc/2NV6-QQAP].

[143] Edward A. Evans & Fredy H. Ballen, *A Synopsis of US Consumer Perception of Genetically Modified (Biotech) Crops*, UNIV. OF FLA. (June 2013), http://edis.ifas.ufl.edu/fe934 [https://perma.cc/4SDJ-87RS].

[144] Amy Paturel & Robin Yamakawa, *The Truth About GMOs*, WEBMD (June 10, 2015), http://www.webmd.com/food-recipes/truth-about-gmos [https://perma.cc/PF9J-VYGN].

remain as to its implementation, short-term measures must be adopted to ensure the orange's long-term survival. Luckily there are a number of such options that can be immediately put into effect.

One of these is the USDA's Tree Assistance Program ("TAP"), which offers funding to citrus growers to replant trees harmed by "natural disasters," which includes HLB.[145] Recently the program was expanded so as to incorporate growers that need to replace declining trees, and who can now receive financial support for up to six years.[146] In the past assistance was denied unless all citrus tree deaths had taken place within one year.[147]

Under this program, growers can receive as much as a fifty percent discount for tree removal, sixty-five percent for replanting, and sixty-five percent for the purchase of seedlings.[148] The only conditions are that no losses have occurred prior to October 1, 2011 and that individual groves have experienced at least a fifteen percent "mortality loss," which could include trees that are no longer commercially viable.[149]

Furthermore, the loss cannot be attributed to a failure to take "reasonable and available measures," and any harm suffered by the trees must be readily apparent to the Farm Service Agency ("FSA") representative.[150] Otherwise there are no restrictions to utilizing this program, which is an excellent avenue for obtaining relief. But it is only one measure the USDA has undertaken to help citrus growers in need.

Last year the USDA set aside $25 million in financial support (provided by the 2014 Farm Bill) for research dedicated to fighting HLB.[151] Additionally, they distributed another $6.5 million to projects associated with the Huanglongbing Multi-Agency Coordination Group ("HLB MAC").[152] These recipients include APHIS, the National Institute of Food and Agriculture, and numerous state departments of agriculture, among others.[153]

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[145] *Tree Assistance Program Fact Sheet*, *supra* note 14.
[146] *USDA Announces Additional Support for Citrus Growers Impacted by HLB*, USDA (Sept. 17, 2014), http://www.usda.gov/wps/portal/usda/usdamediafb?contentid=2014/09/0201.xml&printable=true&contentidonly=true [https://perma.cc/3ZKP-VNUV] (last visited Mar. 27, 2016).
[147] *Id.*
[148] *Id.*
[149] *Id.*
[150] *Tree Assistance Program Fact Sheet*, *supra* note 14.
[151] *USDA Announces Additional Support for Citrus Growers Impacted by HLB*, *supra* note 146.
[152] *Id.*
[153] *Id.*

The HLB MAC Group's stated goal is to "coordinate and prioritize federal research with industry's efforts to complement and fill research gaps . . . and more quickly provide practical tools for citrus growers to use."[154] These projects could prove tremendously helpful in providing new ideas to citrus growers who are desperately in need of them.

And while Florida is currently the sole beneficiary of these efforts, they could easily be extended to other citrus-growing states in the future depending on their level of need and how successful these projects are. This may be a short-term solution, but it is also a practical one, which growers should attempt to utilize to the fullest extent possible.

B. Citrus Greening Eradication Program

The fact that the canker eradication program ultimately failed to accomplish its goals does not mean that the concept should be entirely discarded. Rather Florida should attempt to apply the lessons learned from its past efforts and design a program more likely to accomplish its goals. It will likely require a more modest blueprint as HLB's degree of saturation renders an eradication-focused strategy unworkable.

Additionally, Florida should take particular care to remove only those trees that are infected or stand a significant risk of becoming infected, and design any eradication zone accordingly. It should also go without saying that homeowners be kept informed of anytime when residential tree removal is given serious consideration, and included throughout the entire process. Lack of communication was a major issue in the past.

Above all else it is vital that homeowners be justly compensated for any trees that are removed from their property, and that they be paid the fair market value, which courts have previously determined to be the appropriate measure of damages. It must be remembered that while superficially similar to the prior eradication program this would by necessity be vastly different in nature as but one in a suite of possible options.

Current genetic engineering efforts should be conducted in the same manner, which is to say not in isolation. While initial trials have been successful, there is still no evidence as to how genetically modified trees would fare in a non-controlled environment. Thus it is imperative that genetic engineering be complemented by other projects in developing a truly effective HLB-prevention program.

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[154] *Id.*

C. Heating Treatments

One such project involves killing HLB bacteria through heat application. Researchers have recently published the results of a study demonstrating that heating potted citrus seedlings both destroys the HLB bacterium and removes any trace of HLB-related symptoms.[155] Notably this occurred after the seedlings were exposed to temperatures from 104 to 107°F for a period of forty-eight hours, with anything outside of that range being mostly ineffective.[156]

These results held true for all of the heat treatments, irrespective of exposure time, with perhaps the best piece of news being that even after two years of tests the seedlings were still free of the diseases.[157] And while of course complete elimination of the HLB bacterium cannot be guaranteed, this is clearly a promising avenue of research that merits further exploration.

Another heat-related method of combating HLB may be even more significant by helping to prolong the lives of mature citrus trees. It involves covering the trees in plastic PVC tents for a period of at least a week and then removing the tents and cutting off the uppermost ten to twelve inches of the trees, given that this would be the section most affected by the heat.[158]

The results thus far have been highly encouraging. Within only a brief period of time, leaves that were previously underdeveloped due to HLB were suddenly thriving, and the quality of the oranges had "noticeably improved."[159] Researchers found that trees receiving this treatment no longer needed to be tented and that the severity of HLB-related symptoms had greatly declined even in trees where the disease was fairly advanced.[160]

Furthermore the tents can be reused, and while, after including labor, this method costs roughly $45 per tent, given the results this is felt

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[155] Dennis O'Brien, *Recipe for HLB-affected Citrus: Apply Heat—Lots of It*, USDA (Aug. 5, 2013), http://www.ars.usda.gov/is/pr/2013/130805.htm [https://perma.cc/FD2T-UXRA].
[156] *Id.*
[157] *Id.*
[158] Dennis O'Brien, *Prescription for Curing Citrus Greening*, 61 AGRIC. RESEARCH 4, 6 (Aug. 2013), *available at* http://www.ars.usda.gov/is/AR/archive/aug13/citrus0813.htm [https://perma.cc/X7X5-GSYU].
[159] *Id.*
[160] *Id.*

to be well "worth the effort."[161] Researchers admit that that they are not entirely sure of the reason for this treatment's success, but acknowledge that since HLB is a systemic disease, killing it would most likely entail removing it from the roots.[162]

But while the heating treatments may not be able to completely eliminate the HLB bacterium within the citrus trees, if they are even able to seem to slow the rate of infection and extend a tree's fruit-bearing life that would be more than sufficient. It must be emphasized that this is but one potential measure that could be taken, and would almost certainly be more effective if done in conjunction with other treatments.

D. Parasitic Wasps

One of these treatments involves introducing parasitic wasps that target the ACP into citrus groves. About six year ago a team of Florida entomologists imported two species of parasitic wasps from Taiwan and Thailand, both of them enemies of the ACP.[163] They were first placed under observation to assess their effectiveness against the ACPs and to verify that they posed no threat to the environment.[164] After this was determined the researchers began conducting field tests.[165]

According to the researchers, these wasps have already established a strong presence in Florida and have been so effective at controlling ACPs that it has lowered their numbers by as much as eighty percent in certain areas.[166] Of course, they are also depending on "naturally occurring" predators such as lady beetles and spiders doing their part to keep the ACP population in check.[167]

Unfortunately, since even a single ACP is capable of spreading HLB, this method will not defeat the disease by itself and needs to be

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[161] *Id.*
[162] *Id.*
[163] Chuck Woods & Tom Nordlie, *UF Mobilizes Its Agricultural Scientists To Defend Florida's $9.3 Billion Citrus Industry Against Disease*, 11 EXPLORE MAGAZINE 12, 16 (2006), *available at* http://www.research.ufl.edu/publications/explore/v11n1/story1.html [https://perma.cc/QPS3-KJZ7].
[164] *Id.* at 17.
[165] *Id.*
[166] Kevin Bouffard, *UF researchers are taking a three-pronged approach to fighting a potentially devastating citrus disease*, 18 EXPLORE MAGAZINE 36, 38 (2013), *available at* https://issuu.com/ufexploremagazine/docs/uf_explore_magazine_spring_2013 [https://perma.cc/X3BX-ERX7].
[167] Woods & Nordlie, *supra* note 163, at 17.

incorporated into a more "holistic approach."[168] The researchers also believe that care should be taken to ensure that this or any other method used to combat HLB is compatible with the ACPs' natural enemies as a significant decrease in their population would quickly prove self-defeating.[169]

E. Neutered ACPs

One last area of research that deserves special mention involves replacing normal ACPs with ones that have been rendered incapable of spreading HLB.[170] The primary goal of this project is to interfere with the spread of HLB within groves where HLB is widespread as well as ones where ACPs are established but HLB has not yet been detected.[171] Once released and established, these "neutered ACPs" would then infiltrate and displace the native ACP population.[172]

While traditional ACP control measures such as insecticide application would be continued temporarily, they would eventually be phased out to allow populations of transmission-deficient ACPs to become established.[173] While this method is undeniably ambitious, it is also promising as evident by the $9 million grant the USDA recently approved for its development.[174]

The project team has been given a five-year timeline within which to develop their ACP and introduce it into Florida.[175] Before this can be done, however, they realize they must educate both growers and the general public as to the benefits of this method so as to ensure its adoption.[176] The fact that it involves genetically modifying the ACP would almost certainly guarantee some level of resistance, however, it is difficult to imagine that it could compare to what the GMO orange is currently facing.

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[168] Bouffard, *supra* note 166, at 18.
[169] *Id.* at 17.
[170] Voosen, *supra* note 12.
[171] *Rear and Release Psyllids as Biological Control Agents*, USDA, http://vivo.usda.gov/display/NIFA-0230893-PROJ [https://perma.cc/EK54-5XRA] (last visited Mar. 27, 2016).
[172] *Id.*
[173] *Id.*
[174] *Agriculture Secretary Vilsack Announces Investments in Specialty Crops to Help Strengthen New Markets*, USDA, http://www.csrees.usda.gov/newsroom/news/2012news/10011_scri.html [https://perma.cc/LD3Y-HHKS] (last visited Mar. 27, 2016).
[175] *USDA, NIFA Grant Award*, CITRUS RESEARCH & DEV. FOUND., http://citrusrdf.org/usda-nifa-award [https://perma.cc/43UQ-MKBB] (last visited Mar. 27, 2016).
[176] *See Rear and Release Psyllids as Biological Control Agents*, *supra* note 171.

CONCLUSION

Clearly citrus greening is a complex issue, and if there were an easy solution, it would have presented itself long ago. Unfortunately there is not, and so we are left with a number of imperfect solutions, most of which are unproven and none of which guarantee success. Genetic engineering is one such solution, and has generated a great deal of excitement due to the inherent possibilities in its applications.

However, it is rarely wise to devote all of one's resources to a single strategy, particularly when what is at stake is the identity of an entire state and the livelihoods of thousands of people within it. There may well come a day when all oranges are genetically modified, but so long as this is more theoretical than plausible, we must ensure that we have done everything we can to provide a future where there are any oranges left at all.