CARIBBEAN FOOD CROPS SOCIETY

45

Forty Fifth Annual Meeting 2009

Frigate Bay
Federation of St. Kitts and Nevis

Vol. XLV
Number 1
T-STAR Invasive Species Symposium

PROCEEDINGS
OF THE
45th ANNUAL MEETING

Caribbean Food Crops Society
45th Annual Meeting
July 12-17, 2009

St. Kitts Marriott & Royal Beach Casino
Frigate Bay, St. Kitts and Nevis

"Reality and Potential of Food Security and Agricultural Diversification in Small Island Developing States"

"Realidad y Potencial de la Seguridad Alimentaria y la Diversificación Agrícola en Pequeños Estados Insulares en Desarollo"

"Sécurité alimentaire et diversification agricole dans les petits états insulaires en développement: réalisations et perspectives".

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

INVASIVE SPECIES SAFEGUARDING: IMPERATIVE FOR CARIBBEAN REGIONAL AGRICULTURAL DIVERSIFICATION AND FOOD SECURITY

Special Symposium Edition
Edited by
Waldemar Klassen, Carlton G. Davis, Edward A. Evans, Sikavas Na-Lampang and Wanda Lugo

Published by the Caribbean Food Crops Society

Published by the Caribbean Food Crops Society

ISSN 95-07-0410

Copies of this publication may be obtained from:

Secretariat, CFCS
P.O. Box 40108
San Juan, Puerto Rico 00940

Proceedings of the Caribbean Food Crops Society. 45(1): 125-135. 2009

AMBROSIA BEETLE AND LAUREL WILT THREAT TO AVOCADO PRODUCTION

Dr. Edward. A. "Gilly" Evans[1], Dr. Jonathan Crane[1], Dr. Alan Hodges[2], and Mr. Jason L. Osborne[3].
[1]University of Florida, Tropical Research and Education Center, 18905 SW 280th Street, Homestead, FL 33031; [2]University of Florida, Food and Resource Economics Department, University Avenue, Gainesville, FL 32611 and [3]Miami-Dade County Extension Service, 18710 SW 288 St., Homestead, FL 33030. Corresponding author: EAEvans@ifas.ufl.edu

ABSTRACT. This article describes and provides preliminary estimates of the potential economic losses that could result from an incursion of the recently discovered exotic laurel wilt disease caused by *Raffaelea lauricola*, in the main avocado (*Persea americana*) growing area of Florida. Estimates are provided for both the direct losses as well as the indirect or "spillover" losses that could occur across the rest of the regional economy. The Impact Analysis for PLANning (IMPLAN) input-output multipliers were used in assessing the regional impacts. The results of the investigation indicate the direct loss to the industry in terms of lost sales, property damage, and increased management costs could range from $356 million in a do-nothing situation to about $183 million if damage control measures were 50% effective. If increased management costs and decreased property values are ignored, the adverse impact on the regional economy could range from $54 million in a do-nothing situation to $27 million in a case in which the treatments result in only a 50% reduction in avocado production.

KEY WORDS: *Persea americana* var. *americana*, *P. americana* var. *guatemalensis*, *P. borbonia, P. palustris, Sassafras albidum,* Redbay ambrosia beetle, *Xyleborus glabratus*, *Raffaelea lauricola*, input-output model

INTRODUCTION

The Florida avocado industry is the state's second-largest fruit industry (behind citrus) and is worth $12 to $14 million a year at the farm gate [U.S. Department of Agriculture-National Agricultural Statistics Service (USDA/NASS), 2008] and $30 million at the wholesale end of the market (P. Brooks, personal communication). Approximately 85% of the crop is sold outside of the state; hence the industry brings in a substantial amount of "new dollars" to the state, resulting in an overall economic impact of approximately $54 million per annum (authors' calculation; Degner et al., 2002). The industry consists of about 7,400 acres, representing about 60% of the total tropical fruit crop acreage, and there are about 951 growers (USDA/NASS, 2008; USDA/NASS, 2009; J.H. Crane, personal communication), and 35 registered avocado handlers and shippers (P. Brooks, personal communication). Of these 7400 acres, over 98% are located in southwest Miami-Dade County. The range in orchard size is from 0.1 to over 500 acres (USDA/NASS, 2009). However, 93% of the farms are 15 acres or less and the most common farm size category is one to five acres. Most of these growers depend on proceeds from the sale of avocados to supplement their incomes and, many of the packing-houses depend almost exclusively on the fruit to ensure that their operations remain financially viable. In several of the

packing-houses, the revenue from handling avocados accounts for between 60% and 80% of the total revenue and subsidizes the handling of other less common tropical fruits (C. Wheeling, personal communication). Moreover, avocado orchards provide many non-food benefits, including the retention of open space/landscaping, well-field recharge, recreation/relaxation, wildlife habitats, canopy cover, and carbon sequestration.

Florida grows primarily West Indian (*Persea americana* var. *americana*) and Guatemalan (*P. americana* var. *guatemalensis*) -West Indian hybrid avocados which are smooth skinned, large (up to 40 oz), with less oil and fewer calories than the 'Hass' avocado produced in California, Chile, and Mexico (Crane et al., 2007).

In 2002, the redbay ambrosia beetle (*Xyleborus glabratus*) (Fig. 1) along with its fungal symbiont the laurel wilt pathogen (*Raffaelea lauricola*) was introduced through Port Wentworth, Georgia on contaminated solid wood packing material (Fredriech et al., 2008; Harrington et al., 2008). Within two to three years of the initial introduction extensive mortality of native redbay (*Persea borbonia*) trees (Fig. 2) had occurred in Georgia and South Carolina. In 2005, humans spread the pest into north Florida and by 2007 central Florida (Reid et al., 2009). In 2007, the first avocado (*Persea americana*) tree to succumb to the pest occurred in a home landscape in Jacksonville (Duval County), Florida. Testing in pest infested areas and under greenhouse conditions confirmed avocado susceptibility to the redbay ambrosia beetle attack and damage or death from laurel wilt (Mayfield et al., 2008). The pest continues to move slowly southward 20 to 30 miles per year toward the main avocado production area through the native areas via native host plants such as redbay and swampbay (*P. palustris*) and through the urban landscape via dooryard avocado trees (Crane et al., 2008; Koch and Smith, 2008). However, it could arrive much sooner if introduced inadvertently in contaminated host wood (e.g., redbay firewood, BBQ smoke-wood, etc.). Because the mortality from laurel wilt is so high (>92%) and the discovery that avocado is attacked by the redbay ambrosia beetle the continued existence of the Florida avocado industry is now being seriously threatened (Fraedrich et al., 2008; Mayfield, 2007).

The Florida's avocado industry demise could have catastrophic consequences for the surrounding regional and local economies. Besides direct losses to the state's avocado industry in terms of lost incomes and decreased property values, such an event would generate a chain reaction impacting sales, income, and employment in other related sectors. The purpose of this article is to describe and provide preliminary estimates of the potential losses that could result from an incursion of this disease in the main avocado production area in Florida.

LAUREL WILT DISEASE: ECOLOGY, DAMAGE CAUSED, AND MANAGEMENT OF THE DISEASE.

Laurel wilt is a vascular disease that causes extensive mortality of plants in the Laurel family (Lauraceae). There are numerous species within Lauraceae in Florida, examples include forest species such as redbay (*Persea borbonia*) and sassafras (*Sassafras albidum*) and major commercial fruit crop species such as avocado (Mayfield et al., 2008; Ploetz and Peña, 2007). The laurel wilt pathogen is new to the United States and was first recognized on redbay trees on Hilton Head Island in 2002. Since then, the disease has spread to over 55 counties in Florida, Georgia, and South Carolina. In 2006, the disease was found as far south as Indian River County

and has now spread to Okeechobee, Oceola and St. Lucie counties (Ploetz and Pena, 2008; Reid et al., 2009).

The disease is vectored by the redbay ambrosia beetle. The adult female beetle carries the spores of the laurel wilt pathogen in special mouth pouches called mycangia and on its body (Fraedrich et al., 2008; Harrington et al., 2008). As the beetle bores into the wood, forming galleries, the spores on its body inoculate the tree, germinate, and grow, colonizing the outer wood (sapwood) of the host plant. The fungal hyphae block water and nutrient movement in the sapwood, resulting in eventual tree death (Crane et al., 2008). The entire process from the time the tree becomes infected with the fungus until death may occur in a matters of weeks to several months (R. Ploetz, pers. comm.).

At present there are no registered fungicides for avocado that will control laurel wilt. While chemical and or biological control of the vector might be a possibility, not much research currently exists to implement the program prior to infestation (Koch and Smith, 2008). Chemical control of the beetle is complicated by the fact that adult beetles must be in the immediate area of aerial sprays to be controlled. Detection of adult beetles involves setting and monitoring traps and/or scouting orchards. Once the adult beetles bore into the trees, contact insecticides are ineffective (Crane et al., 2008). In the absence of any effective control treatments, growers are being advised to be vigilant for signs of the beetle. Limbs and branches of redbay ambrosia beetle infested trees in commercial orchards should be removed and burned. The initial (first one to two) trees that have died from an infestation should be cut and burned since chipping will not kill the developing larvae. Trees that are not destroyed by burning remain a source of new beetle infestations. However, tree destruction may not inhibit the spread of the beetle once established in an area nor be an economically viable solution to prevent further infestations. In addition, as a type of prophylactic treatment, growers have been advised to apply permethrin [Permethrin 3.2 AG (Arysta LifeScience North America Corp., Cary, NC) or Permethrin 3.2 EC (Helena Chemical Co, Collierville, TN)] to the trunk and major limbs from the base of the tree up to about 10 feet above the ground from March through December (Crane et al., 2008). However, the effectiveness of this treatment has not been tested.

MATERIALS AND METHODS

Quantifying the potential losses that could result from the establishment of the pest and disease involves estimating both the direct losses to the avocado industry as well as the indirect or "spillover" losses that could occur across the rest of the regional economy. The direct losses include lost income, lower property values, and increased management costs, including the costs associated with surveillance, plant protection products, the loss/disposal of infected trees and potentially replanting with tolerant or resistant avocado cultivar. Quantifying the secondary or indirect impacts is much more challenging and requires the use of an input-output model such as IMPLAN (Miller and Blair, 1985). Such a model describes the regional economy as represented by a set of input-output tables that capture the supply and demand of goods and services in the region, as well as the interdependencies among industries and the associated primary factors of production. For example, the avocado industry has a direct requirement for inputs such as chemicals, fertilizers, and packing materials from the manufacturing sector as well as transportation services. These sectors, in turn, require energy inputs to process their products and

transport goods. A decrease in the production of avocados reduces the demand for products and services, and labor, which consequently reduces incomes earned by households, thus creating an adverse ripple effect throughout the regional economy.

The total regional economic impacts were estimated using IMPLAN input-output multipliers, which capture the indirect and induced effects of sales outside Florida that bring new money into the region and generate further economic activity as these dollars circulate through the economy (Minnesota IMPLAN Group Inc., 2007). Indirect effects represent the economic activity generated by businesses that furnish inputs to the agricultural and natural resource industries, while induced effects represent the impacts of industry employee household spending.

Because both the ambrosia beetle and laurel wilt disease are recently identified pests and the exact effects of treatments cannot be known for certain three scenarios were investigated based on the worse case estimates provided by scientists researching and managing the disease complex. The first scenario is the base case or the do-nothing scenario. The second considers the situation in which production loss equals 75%, implying that the treatment were only 25% effective. And the third scenario is when production loss equals 50%.

RESULTS AND DISCUSSION

Direct cost estimates. The direct cost estimates are broken down into three categories: potential sale losses, decreased property values, and increased management costs.

Potential sale losses. As noted earlier, at the wholesale level of the marketing chain, the industry is worth approximately $30 million dollars. Given that in the worst-case scenario the disease could destroy the entire industry, this value represents the maximum potential sales loss (Table 1).

Table 1. Estimates of the direct economic loss associated with potential infestation of the redbay ambrosia beetle - laurel wilt pathogen of the avocado orchards in South Florida.

Item	Baseline ($)	75% reduction in production ($)	50% reduction in production ($)
Industry sales loss (avocados)	30,000,000	22,500,000	15,000,000
Decline in property value	326,250,000	244,688 ,000	163,125,000
Increased management costs	-	4,525,000	4,525,000
Total value	356,250,000	271,713,000	182,650,000

A 75% or 50% reduction in the crop could result in potential sale losses of $22.5 million and $15 million, respectively. Since it is felt that any such declines could easily be replaced by imports, no price adjustments were made for the expected decrease in the domestic production of avocados. Countries such as the Dominican Republic produce similar cultivars and could within a short time increase avocado exports to the United States. In addition, some consumers would likely switch to another variety, namely Hass avocados, which is the main variety produced in California and imported from Mexico and Chile. Not included in the estimates are anticipated declines in sales of nursery avocado plants (in the presence of the vector and disease, growers would be less likely to replace trees that are damaged or killed) or the lost value of non-commercial avocado production.

Decline in property value. Real estate is a major asset on the farm sector balance sheet, accounting for nearly 79% of the total U.S. farm assets in 2000 [U.S. Department of Agriculture/Economic Research Service (USDA/ERS) Briefing Room, 2008]. Several factors contribute to the market value of farmland, including speculation, land productivity, and the profitability (net income) of the commodity grown. Avocado production is one of the most profitable orchard crops grown in South Florida. Evidence of this is the fact that more than one-half of the tropical fruit crop acreage is planted with avocados. A disease such as laurel wilt in the absence of any effective treatment would most likely result in decreased property values.

To assess the potential for a decline in property values, we estimated the value of an established orchard based on the estimated value of a mature avocado tree using the internet tool Tree Value Analysis (Evans et al., 2006). Using the tool and inserting a farm gate price of avocado of 45 cents per pound [2007 average growers price, U.S. Department of Agriculture, National Agricultural Statistics Service (USDA/NASS)] and the cost for stump removal of $150 per tree (Evans, 2006), we estimate the value of a mature tree to be around $500. At an estimated value of $500 for a mature tree and an assumed planting density of 87 trees per acre (University of Florida/Institute of Food and Agricultural Sciences, Florida Cooperative Extension Service recommendation), the additional value of an established avocado grove is assessed at $43,500 per acre. With the current market value for an avocado grove being in the vicinity of $80,000 per acre, such a decline would represent a loss of approximately one-half of the market value. If the total bearing acreage of 7400 acres were to be destroyed, property values could plummet by about $326 million (Table 1). In other words, growers could see their net worth (wealth) decreased by this amount, which could affect their willingness to continue producing avocados. This estimate does not include non-bearing or immature orchards, which most likely would also be affected if the disease were to become established.

Increased management costs. Avocado production in South Florida has not had any major insect pests threatening production. To date, the main threats faced by South Florida growers have been damages caused by tropical storms and phytopthora (root rot due to flooding). Consequently, the amount spent on pest and disease management and cultural controls as an overall percentage of operating costs has been relatively small compared with other fruit crops such as mango (C. F. Balerdi, personal communication). However, the situation could change with the imminent arrival of vectors and the associated pathogens.

As discussed earlier, currently there are no registered fungicides for avocado that will control laurel wilt disease. Moreover, control or eradication of the main vector, ambrosia beetle, is complicated due to its ability to bore into tree trunks and branches. Consequently, growers have been advised to adopt a prophylactic approach involving the periodic application of permethrin which costs about $105 per gallon. Based on the recommended rate of application of about 8 ounces per acre, the material cost per acre per treatment is $6.50. Adding to this the application cost (labor and machinery) of $12 per acre, the total cost per application is estimated at $18.50 per acre. Given that, on average, 18 applications would be required per annum, the production cost could be expected to increase by $333 per acre, per annum. Assuming all the avocado acreage (7400) was treated at this rate, the total cost would increase by about $2.5 million per annum (Table 1). To this amount is added the sum of $2 million, estimated as the additional cost that would be incurred, given the increased frequency of monitoring/scouting for the disease. In

calculating the latter, it is assumed (based on the advice of industry experts and extension agents) that scouting would have to be conducted at least nine times per annum, at an estimated total cost of $270 per acre. This estimate does not include the costs of burning infected branches and trees or the cost for insect trap and kill systems. Research is in progress with short-term and long-term strategies for control. These include chemical control of redbay ambrosia beetle and laurel wilt pathogen, development and use of repellents and trap and kill insect systems, and eventually biological control.

Secondary cost/Economic impact. Input-output (I-O) analysis is used to estimate the economic effects of the laurel wilt disease on the regional economy. Specifically, Table 2 shows the base line situation (Scenario 1) as well as the economic impacts resulting from a 75% (Scenario 2) and 50% (Scenario 3) reduction in output, respectively. Only the direct sales losses (not the assessed decline in property values or increased management costs) are used in the analysis to reflect the changes in the value of avocado production. As shown in Table 2, under Scenario 2, a 75% reduction in avocado production would cause the direct sales output to fall from $30 million to $7.5 million (implying sales losses of $22.5 million).

Table 2. The potential economic impacts of the redbay ambrosia beetle - laurel wilt pathogen on the regional economy of South Florida.

	Scenario 1- base case ($)	Scenario 2 - 75% reduction in production	Scenario 3 - 50% reduction in production
Industry sales (output)	$30,000,000	$7,500,000	$15,000,000
Share of avocado production shipped outside the production area	85%	85%	85%
Output impacts	$54,266,259	$13,566,565	$27,133,130
Employment impacts (jobs)	546	136	273
Labor income impacts	$19,674,272	$4,918,568	$9,837,136
Indirect business tax impacts	$1,862,415	$465,604	$931,208

The reduced sales output reduces the demand for inputs from other related sectors, such as the chemical, fertilizer, and transportation sectors (indirect impact), causing such sectors to cut back on their economic activity. As shown in Table 2, the consequence of such actions is that total sales (economic impact of all related sectors) would decline by $40.5 million, from $54 million to about $13.5 million. The reduction in economic activity due to the reduction in avocado production as well as in related input sectors causes a reduction in the demand for labor. Table 2 shows that employment (in terms of full-time equivalent) would decline from 546 to 136 employees. The reduction in the need for labor resources reduces the amount paid out, causing labor income to fall from $19.7 million to under $5 million. Government revenues in the form of indirect business tax would also be adversely affected, as the contraction of the regional economy due to reduced sales would cause indirect business taxes to fall from $1.9 million to $0.5 million, a decline of 73%.

A similar situation would be observed under Scenario 3, except that the magnitude of the economic impact would be less severe but still substantial. Hence, under the latter, the total economic impact would decline from $54 million to $27.1.

CONCLUSIONS

Together, the ambrosia beetle and laurel wilt disease represent a serious threat to the Florida avocado industry. Currently, the industry generates an economic impact of over $54 million dollars, contributes to agricultural labor employment, and is a source of $1.9 million annually in government revenue. Many of the local packing-houses depend almost exclusively on this crop to sustain their operations. Moreover, the industry contributes several non-market benefits such as open space retention, canopy cover, carbon sequestration, and wildlife habitats.

Our economic analysis indicates that if laurel wilt disease were to become established in the main avocado industry, the direct loss to the industry in terms of lost sales, property damage, and increased management costs could range from $356 million in a do-nothing situation to about $183 million if damage control were 50% effective. If increased management costs and decreased property values are ignored, decreased economic activity (economic impact) could range from $54 million in a do-nothing situation to $27 million in a case in which the treatments result in only a 50% reduction in avocado production. Notwithstanding, the impact on the local economy would be catastrophic if this occurred since many of the packing-houses would no longer be able to remain in business. Even if the packing-houses that remain in operation became major redistributors for imported produce, this would not be enough to offset the losses to the local economy. Moreover, our assessment of the impacts can be considered as conservative since no attempts were made to quantify the economic impact on non-commercial production (residential infestations) avocados or forest trees, scenic beauty/esthetics, wildlife, and the loss of canopy cover.

In light of the magnitude of the impacts and potential losses associated with laurel wilt disease, it is imperative that efforts be made to implement policies that will decelerate the spread of the disease and to invest in research that could lead to the development of effective treatments and preserve the industry.

REFERENCES

Crane, J.H., C.F. Balerdi, and I. Maguire. 2007. Avocado growing in the Florida home landscape, Circular 1034. Hort. Sci. Dept., Fla. Coop. Ext. Serv., Inst. Food and Agr. Sci., Univ. of Florida, Gainesville, Fla.

Crane, J. H., J. Pena, and J. L. Osborne. 2008. Redbay Ambrosia Beetle-Laurel Wilt Pathogen: A Potential Major Problem for the Florida Avocado Industry, HS1136. Hort. Sci. Dept., Fla. Coop. Ext. Serv., Inst. Food and Agr. Sci., Univ. of Florida, Gainesville, Fla.

Evans, E., C. Balerdi, J. Crane, and S. Nalampang. 2006. Determining the value of an orchard tree. Food and Resource Econ. Dept., Fla. Coop. Ext. Service, Inst. Food and Agr. Sci., Univ. of Fla., Gainesville, Fla.

Fraedrich, S.W., T. C. Harrington, R. J. Rabaglia, M. D. Ulyshen, A. E. Ayfieldiii, J. L. Hanula, J. M. Eickwort, and D. R. Miller. 2008. A fungal symbiont of the redbay ambrosia beetle

causes a lethal wilt in redbay and other Lauraceae in the southeastern United States. Plant Diseases 92:215-224.

Harrington, T.C., S.W. fraedrich and D.N. Aghayeva. 2008. *Raffaelea lauricola*, a new ambrosia beetle symbiont and pathogen on the Lauraceae. Mycotaxon 104:399-404.

Koch, F. H. and W. D. Smith. 2008. Spatio-temporal analysis of *Xyleborus glabratus* (Coleoptera: Circulionidae:Scolytinae) invasion in eastern U.S. forests. Environ. Entomol. 37: 442-452.

Mayfield III, A.E. 2007. Laurel wilt: a serious threat to redbay and other related native species. The Palmetto 24:8-11.

Mayfield III, A.E., J.E. Pena, J.H. Crane, J.A. Smith, C.L. Branch, E.D. Ottoson, and M. Hughes. 2008. Ability of the redbay ambrosia beetle (Coleoptera: Curculionidae: Scolytinae) to bore into young avocado (Lauraceae) plants and transmit the laurel wilt pathogen (*Raffaelea* sp.). Fla. Entomologist 91:485-487.

Minnesota Implan Group, Inc. 2007. Implan (professional, economic impact analysis and social accounting software) and Florida State Data Package. Minnesota Implan Group (October), Stillwater, Minnesota.

Miller, R. E. and P. D. Blair. 1985. Input-Output Analysis: Foundations and Extensions. Prentice-Hall, Englewood Cliffs, New Jersey.

Ploetz, R. C. and J. E. Peña. 2008. Laurel wilt: a lethal disease on avocado and other Lauraceous hosts. Tropical Research and Education Center, University of Florida, Homestead, Florida. 23 May 2009. < http://trec.ifas.ufl.edu>.

Reid, L., B. Mayfield, and J. Johnson. 2009. Distribution of counties with laurel wilt disease symptoms by year of initial detection. 23 May 2009. < http://www.fs.fed.us/r8/ foresthealth/laurelwilt/dist_map.shtml>.

U.S. Department of Agriculture. 2008. Noncitrus fruits and nuts preliminary summary, January, 2008. 10 Mar. 2009. <http://usda.mannlib.cornell.edu/usda/current/ NoncFruiNu/NoncFruiNu-01-23-2009_revision.pdf>.

USDA/ERS Briefing Room 2008. Land Use, Value, and Management: Agricultural Land Values. 20 Dec. 2008 <http://www.ers.usda.gov/Briefing/landuse/ aglandvaluechapter.htm.

USDA/NASS. 2008. Noncitrus fruits and nuts: 2008 preliminary summary, Fr Nt 1-3 (09) a. USDA-National Agricultural Statistic Service. 22 May 2009. <http:// usda.mannlib.cornell.edu/usda/current/NoncFruiNu/NoncFruiNu-01-23-2009_revision.pdf>.

USDA/NASS. 2009. 2007 Census of agriculture, Florida – state and county data, volume 1: Graphic area series, part 9. U.S. Dept. Agr., Natl. Agr. Stat. Serv., Washington, D.C. 10 Apr. 2009. <http://www.agcensus.usda.gov/Publications/2007/ Full_Report/Volume_1,_Chapter_1_State_Level/Florida/flv1.pdf>.

Fig. 1. Redbay ambrosia beetles (Xyleborus glabratus): a) comparison of beetle to a penny; b) top view and c) side view of a single adult. (Credits:IPMimages.org and http://edis.ifas.ufl.edu/HS391)

Fig. 2. Impact of Laurel Wilt Disease on Red Bay (*Persea borbonia*)
Photo credits: http://www.fl-dof.com/publications/fh_pdfs/Laurel_Wilt.pdf)

DISCUSSION

Mr. Bruce Lauckner. The floor is now open for discussion. Okay I see four people have their hands up. Please ask your questions quickly First Mr. Gibbs, and then Mario Fortune.

Mr. Ian Gibbs. This is a question for Gilly Evans. Are there any natural enemies known of the redbay ambrosia beetle, *Xyleborus glabrata*?

Dr. Edward "Gilly" Evans. I will ask Aaron Palmateer to answer your question.

Dr. Aaron Palmateer. I am a plant pathologist. Dr. Jorge Peña is the entomologist on this project. I know that Jorge is attempting to learn about the biological control of the redbay ambrosia beetle, but I am not familiar with the status of this effort.

Dr. Edward "Gilly" Evans. Yes, one of the problems we have been having is the control of the vector. The beetle is so small that you can scarcely see it; and if just one of them bores into the tree, disease will ensue. Jorge Peña is planning a trip to Taiwan to search for natural enemies.

Editor's Note: The above question was forwarded to Dr. Jorge E. Peña and he stated: "We have identified local predators and there are some parasitoids that have been collected from trunks that are infested with the redbay ambrosia beetle. That being said, from collection of these organisms to know if they are indeed predators or parasitoids of the beetle is a long way. We are trying to fill that gap in knowledge, but this is a slow process." Dr. Peña is seeking T-STAR funding to pursue this work. Dr. Richard Baranowski, with some funding from Dr. Peña, will travel to Thailand in the spring of 2010 and search for parasitoids of related *Xyleborus* species. ARS, USDA may send a specialist to search for natural enemies in Bangladesh. Dr. Peña has found a willing cooperator in Taiwan but work cannot proceed unless grant funds are secured.

Mr. Ian Gibbs. Gilly, do you know if the ambrosia beetle has secondary hosts among the plants used in the ornamental trade? As you know there is a substantial trade of ornamentals between Florida and the Caribbean, including the Cayman Islands where we are from. Do you know if the regulatory agencies have examined the protocols to help prevent exporting this pest?

Dr. Edward "Gilly" Evans. I know the ambrosia beetle attacks plants in the laurel family (Lauraceae), which includes sassafras, swamp bay, red bay, camphor, cinnamon, spicetree, etc. Redbay is used as an ornamental in Georgia, but I do not know which other species in the Laurel Family are involved in the ornamental trade. Even in California, there is a bay, the California Bay, which is a host of this beetle.

Dr. Mario Fortune of Trinidad and Tobago. Are the pathogen's spores spread by the beetle? Are they spread by wind and rain?

Mr. Edward "Gilly" Evans. Aaron can answer this better than I can. Aaron, please.

Dr. Aaron Palmateer. The beetle is the primary vector. However we have conducted inoculation studies which show that the fungus in the absence of the beetle can cause disease. At

least theoretically, the disease can be spread without the aid of the beetle. Infected redbay logs used throughout Georgia and Florida as firewood mediate the spread of the disease. Another thing, just in case you may be interested, there are several fungicides highly effective against the pathogen. The problem is that with fruit-bearing trees there are limitations on which fungicides can be used. We are attempting to identify a highly effective fungicide that can be used with fruit-bearing avocadoes.

Unidentified participant. If the pathogen were introduced onto an island without the beetle to vector it, would the disease die out? Are there circumstances where the disease would die out even if both vector and pathogen had been introduced?

Dr. Aaron Palmateer. The fungus sporulates readily within the cavities in the beetle's jaws (mycangia) and the spores germinate when they are deposited in the sapwood. Probably the conditions for sporulation are very specific, so it is not likely that spores would be produced outside of the beetle or in the absence of the beetle. However conditions under which the disease would spontaneously die out are not known.

Unidentified participant. Does the beetle feed on both living and dead wood?

Dr. Aaron Palmateer. The beetles are strongly attracted to stressed trees. Healthy trees are not attractive to the beetle, and it has been shown that healthy trees are not very susceptible to beetle attack. Dying and dead trees are highly attractive to them.

Unidentified participant. Would this information have application to shipping pallets and ISPM 15, -the International Phytosanitary Measure required for treating pallets, wood crates and dunnage used in international trade?

Dr. Edward "Gilly" Evans. Well, yes. It is believed that the ambrosia beetle was transported to the USA in wood packaging material shipped from southeast Asia to Georgia.

Unidentified participant. I have a question for Dr. Meissner. How is it possible that unwanted wood boring insect species are being intercepted at ports of entry in wood packing materials that has been treated in accordance with ISPM 15?

Dr. Heike Meissner. Well there are a number of possible reasons and combinations of reasons. Firstly it may be that the treatment applied to meet the ISPM 15 standard is not fully effective against certain species of pest. Secondly, it may be that the treatment applied to meet the ISPM 15 standard is not always applied properly or uniformly to the whole pallet. Thirdly, intentional fraud may occur in that the IPPC Seal of Compliance may have been stamped on the wood even though it was not treated. Fourthly the wood may have become infested after it had been treated and stamped. Which of these reasons applies most frequently may be a function of the country of origin and the species of pest.