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FE988

Estimated Costs and Regional Economic Impacts of the Oriental Fruit Fly (*Bactrocera dorsalis*) Outbreak in Miami-Dade County, Florida[1]

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Highlights

- Oriental fruit flies were first detected in Miami-Dade County on August 26, 2015, and as of January 2016, 165 flies have been collected.
- The eradication campaign involves the creation of a quarantine area with three roughly concentric areas. The first area is a 200-meter radius around larval or female fly finds, which is completely stripped of fruits, vegetables, and other host products to eliminate the threat of fly reproduction. The second section is the area in a one-half-mile radius around fly (any life stage or sex) finds, where harvest is only allowed if a postharvest treatment procedure is followed. The third section is an 81-square-mile quarantine area around fly finds, where harvest is allowed if a 30-day pre-harvest treatment or a postharvest treatment is followed.
- Three scenarios of losses are estimated, all of which include direct losses as a result of the quarantine protocol and a potential non-planting response by growers in Miami-Dade County. Looking at three scenarios, the optimistic scenario estimated losses to growers at $4 million, the mid-range scenario estimated losses to growers at $10.7 million, and the pessimistic scenario estimated losses to growers at $23 million. The associated total economic impacts to the county, including indirect and induced multiplier effects, were estimated at 124 to 726 full-time and part-time jobs, and $10.2 million to $58.5 million in industry output.
- The agencies involved in the response efforts to the fruit fly outbreak are expected to spend an estimated $3.5 million by the end of the quarantine period if no additional fruit flies are found.

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Introduction

The Oriental fruit fly (*Bactrocera dorsalis*) is a very destructive pest of fruits that has become established in several areas, including Southeast Asia, the Pacific Islands, and Hawaii, and has been eradicated numerous times from California and Florida (Weems et al. 1999). The United States Department of Agriculture (USDA) lists more than 400 potential hosts of this fruit fly, including fruit and vegetable crops of importance in Florida such as avocados, citrus, green peppers, papaya, and tomatoes (USDA undated). Gravid females puncture the fruit and lay eggs that hatch into larvae and feed on the pulp of the fruit, making it unfit for fresh consumption or processing. Infestation rates as high as 80% have been recorded in fruits such as pear, peach, apricot, and fig (Weems et al. 1999).

Oriental fruit flies were first detected in the Redland area of Miami-Dade County on August 26, 2015, and as of January 2016, 165 flies have been captured. The detection of multiple flies triggered an eradication program and establishment of a quarantine area (Steck 2015, Figures 1 and 2), as authorized in Florida Statute (F.S.) 581.031 and defined in 5B-66 Florida Administrative Code (F.A.C.). The quarantine area is composed of agricultural operations and nonagricultural properties, such as residential and commercial areas. As part of the effort to eradicate the fruit fly, growers and packers in the quarantine area are required to sign a compliance agreement that outlines the procedures necessary for harvesting, handling, and postharvest processing of agricultural products that may serve as hosts for any life cycle of the fruit fly. The compliance agreement stipulates that host material in the quarantine area can only be harvested after the grower completes a 30-day pre-harvest treatment that includes sprays of pesticide bait in and around the harvest area, or through a postharvest treatment. In addition, whenever female flies or any larval stages of the fly are found, the area in a 200-meter radius around the positive find is stripped of all host material, and the soil is drenched with a pesticide to ensure fruit fly pupae are eliminated. Similarly, host products in a one-half-mile radius around positive female or larval finds can only be brought to market after a postharvest treatment of the commodity is completed.

The objective of this article is to provide estimates of the direct and indirect losses to Florida's agriculture and related sectors as a result of the Oriental fruit fly outbreak and ensuing quarantine and eradication programs. The rest of the article is organized as follows. In Section 2, the extent of the quarantine area and the types of losses accrued by growers in each of the areas under quarantine are discussed. Section 3 discusses the expected gross returns for affected crops in Miami-Dade County. Section 4 provides an overview of the commodities grown in the non-core quarantine area, along with the number of acres of each commodity within the quarantine area registered with the state department of agriculture. In Section 5, the realized losses of growers and state agencies—lost revenue and treatment costs—as a result of the outbreak and ensuing eradication and quarantine efforts are estimated. Section 6 provides some alternative scenarios of total financial losses. In Section 7, the regional economic impacts of the oriental fruit fly outbreak and eradication protocol are estimated. Finally, Section 8 completes the article by providing some conclusions.

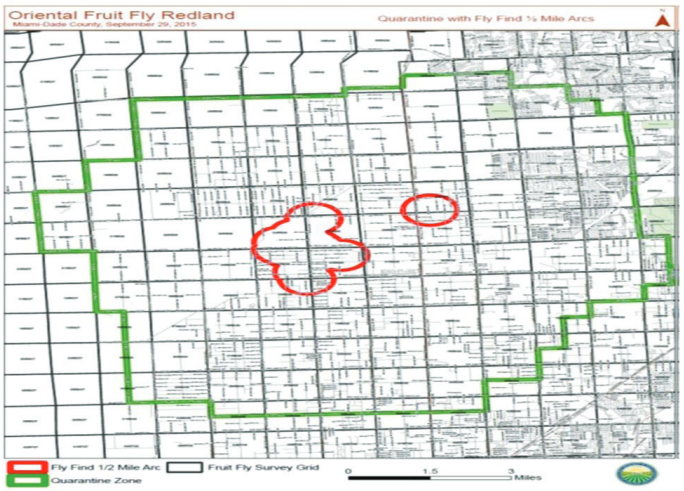

Figure 1. Oriental fruit fly, one-half-mile radius and quarantine areas (Source: FDACS/DPI [2015])

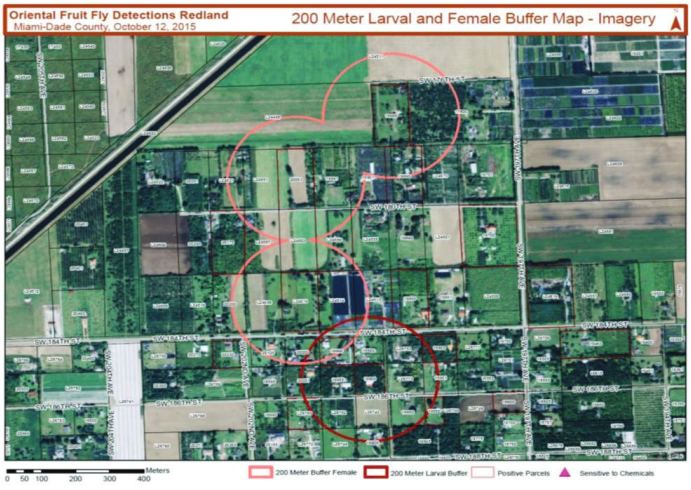

Figure 2. Oriental fruit fly, 200-meter radius area (Source: FDACS/DPI [2015])

Quarantine Zone and Restictions

While the quarantine area is composed of at least 81 square miles around a fruit fly find (5B-66 F.A.C.), there is a "core area" at its center that is composed of two smaller areas. The

first is the 200-meter area, or the area in a 200-meter radius of a female or larval find (Figure 2). The second is the one-half-mile area, or the area in a one-half-mile radius of a fly find (Figure 1). Protocols are different in each of these three areas (200 meters, one-half mile, and non-core quarantine). Therefore, the types of direct costs incurred by growers in each area are significantly different. In addition, growers throughout the three areas may have incurred losses as a result of decisions not to plant or to stop planting due to the presence of fruit flies and the associated eradication protocol. Given the parameters of the eradication program, the following four major costs to growers in the quarantine zone can be identified.

1. 200-meter area: The host material in the 200-meter radius of a female and larval find must be stripped, double-bagged, and disposed of in a landfill. Growers in the 200-meter radius will lose one year's worth of commercial harvest of their products. In the case of mamey sapote, growers will lose two years' worth of production, because the trees hold two years' worth of fruit at any given period.

2. One-half-mile area: The host material in a one-half-mile radius around a fly find will only be allowed to be harvested and sold if the grower is willing to follow a postharvest treatment option. Some postharvest treatment options include fumigation, cold-treatment storage, irradiation, or processing (freezing, pickling, mashing, etc.). However, there are no certified postharvest treatment facilities in Miami-Dade County, and it is logistically difficult to move produce to processing facilities outside the area. In addition, postharvest treatment is expensive and reduces produce quality and market shelf-life for some crops. For other crops, postharvest treatments are either unavailable or unfeasible. In this analysis, we assume that 98% of growers required to follow postharvest treatment will in effect lose the affected products.

3. Non-core quarantine area: Growers in the quarantine area but outside the 200-meter and one-half-mile radius of female and larval finds must follow a 30-day pre-harvest treatment option or approved postharvest treatment to be able to harvest their produce. The pre-harvest option involves sprays of pesticide bait in and around the harvest area at a 6-day to 10-day interval. For this analysis, the assumed cost of the pre-harvest treatment option is $88.60 per acre (this cost estimate was derived as a weighted average and includes the purchase of the chemical and 6 applications of GF-120 in organic operations and Malathion in conventional operations). In addition, growers following a restrictive 30-day pre-harvest treatment plan are likely to suffer some losses associated with fruit drop, spoilage, and reduced postharvest shelf-life. The rate of loss associated with fruit drop, spoilage, and reduced postharvest shelf-life is particularly sensitive to weather-related variables such as temperature, with higher temperatures resulting in crops maturing more quickly than expected, and lower temperatures resulting in crops maturing more slowly than expected. The higher than usual temperatures experienced in Miami-Dade County during the fall and winter of 2015 are estimated to contribute to high rates of product loss as crops become ready for harvest before the 30-day pre-harvest treatment is completed. We assume that 5% of the harvest in the non-core quarantine area is lost to fruit drop and spoilage.

4. Growers not planting annual crops: As a response to the perceived risk associated with the oriental fruit fly outbreak, some growers may have chosen not to plant their annual crops in the 2015/16 season. Some of these annual crops include cucumbers, tomatoes, squash, beans, eggplant, zucchini, calabaza, and peppers. These potential losses are captured using average net returns for vegetable crops (Table 6) and a series of non-planted acreage scenarios (Table 7).

The Florida Department of Agriculture and Consumer Services, Division of Plant Industry (FDACS/DPI), has mapped the extent of the quarantine zone, and the most current maps can be found at the oriental fruit fly information website (FDACS/DPI 2015). The acreage and square mileage of the non-core quarantine area, one-half-mile area, and 200-meter area are summarized in Table 1. It is important to note that only portions of the sections listed in Table 1 are engaged in agricultural operations.

Tropical Crop Expected Gross Returns, Miami-Dade County

A review of crop budgets available in the literature yielded estimates of the expected annual revenues for multiple fruits and vegetables grown in Miami-Dade County. While several of the reviewed studies are specific to Florida (Evans 2014; Evans and Bernal Lozano 2010; Evans et al. 2004, 2010, 2012; Roka et al. 2015; Vansickle et al. 2009), a number of them are from other US locations where these products are grown, such as Georgia and Kentucky (Ernst et al. 2013; UGA 2000, 2014; UGA-VT 2013). Crop budgets were not available for several of the affected crops, including annona, coconut, palms, passion fruit, sapodilla, and tree farms. Therefore, the combined average expected

return for all fruit and vegetable crops was also calculated, and this average is assumed to be representative of the commodities for which information was not available (the average expected returns for fruit crops exclude carambola and dragon fruit, while those of vegetable crops exclude tomatoes; these high-valued crops are considered outliers). The expected annual gross revenues per acre for these commodities are summarized in Figure 3.

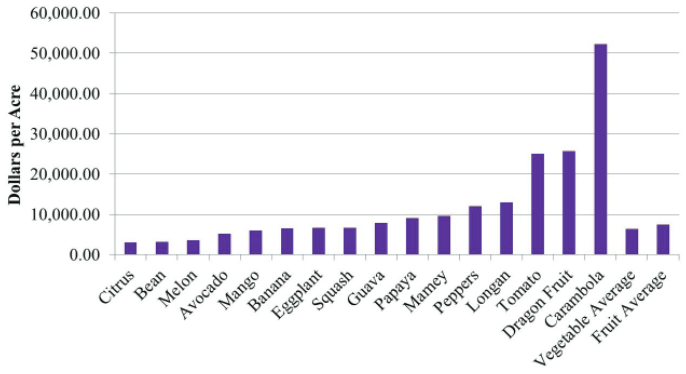

Figure 3. Average annual gross revenues per acre for select fruits and vegetables (Sources: Various)

Quarantine Acreage Composition

As part of the compliance agreement, growers in the quarantine area who are planning to harvest must submit a detailed list of production acreage in the affected area. This information, obtained directly from unpublished records compiled by FDACS, was used to develop a tally of the production acreage that has completed pre-harvest treatment requirements by crop (Table 2). These records provide detailed counts of the acreage by commodity in the quarantine area but outside the 200-meter and one-half-mile areas.

For the purposes of estimating direct costs to growers, the production area under quarantine can be divided into three major areas. The first is the area in the 200-meter radius around female and larval fly finds (200-meter area) whose production is lost for a one-year period (two years for mamey sapote). The second is the area that lies within a one-half-mile radius of any fly finds (one-half-mile area), with an assumed 98% loss rate. The third is the area that must be sprayed with pesticide baits as part of the 30-day pre-harvest treatment or postharvest treatment (non-core quarantine area), which at the latest tally totaled 3,380.26 acres.

While the extent and composition of agricultural production in the third area (non-core quarantine area) is known, the extent and composition of agricultural production in the other two areas (200-meter and one-half-mile areas) must be estimated by developing assumptions on the proportion of the production acreage that falls within each area. These assumptions (Table 3) are slightly different than the actual proportions listed in Table 2 and have been revised to consider the possibility of denser agricultural operations within the 200-meter and one-half-mile areas compared to the non-core quarantine area. An additional assumption is that the composition of agricultural operations is the same in all three areas. The resulting estimated acreages by commodity in each of the three areas under quarantine are summarized in Table 4.

Eradication Estimated Losses

Losses in 200-Meter Area

An estimated 2% of the production area under quarantine is expected to be subject to host material stripping because it lies within a 200-meter radius of female and larval fly finds. This acreage is subject to total losses in production for a period of one year, or two years in the case of mamey sapote (Table 4). To estimate the total losses to growers who are subject to host material stripping, the estimated acreages in this category were multiplied by the annual revenues per acre for the specific crop if information for the crop was available, or by the average revenues for the applicable crop category if information for that particular crop was unavailable. Plant nurseries (e.g., palm and tree farms) are assumed to lose $2,000 per acre beause fruit would have to be stripped from trees for sale and soil would have to be drenched with pesticide, but the trees themselves would not face sale restrictions or destruction. The results are summarized in Table 5.

Losses in One-half-Mile Area

An estimated 5% of the production area under quarantine is expected to be subject to postharvest treatment because it lies within a one-half-mile radius of a fly find. According to the assumptions used in this analysis, 98% of this acreage will be subject to a de facto loss in production for a period of one year (Table 4). To estimate the total losses to growers subject to postharvest treatment, the estimated acreages in this category were multiplied by 0.98 (to reflect the 98% loss assumption) and by the annual revenues per acre for the specific crop if information for the crop was available, or by the applicable average revenues if information for that particular crop was unavailable. The results are summarized in Table 5.

Losses in Non-Core Quarantine Area

A majority of growers in the production area under quarantine will be able to continue normal operations, except for the added requirement of treating the harvest areas for 30 days prior to harvest. An estimated 93% of the agricultural production acreage under quarantine is expected to be subject to pre-harvest treatment (Table 4). To estimate revenue losses to growers subject to pre-harvest treatment, the estimated acreages in this category were multiplied by 0.05 (to reflect the 5% loss assumption) and by the annual revenues per acre for the specific crop if information for the crop is available, or by the applicable average revenues if information for that particular crop is unavailable. This loss in revenue was added to the estimated cost of pre-harvest treatments—which are calculated as the product of the estimated acreages in the non-core quarantine zone and the assumed $88.60 per-acre cost of pesticide bait sprays—to develop an estimate of total financial losses in the non-core quarantine zone. The results are summarized in Table 5.

Losses from Non-Planting Decisions

Growers who decide not to plant will not incur the variable costs associated with planting and harvesting. However, they also will not receive the gross revenues they were expecting in the present planting season. Hence, they will experience a per-acre loss equivalent to their expected gross margin (i.e., gross revenues minus variable costs). Because the composition of crop acreage that will not be planted as a risk mitigation strategy against the oriental fruit fly is unknown, the average gross margins of five annual crops in the non-core quarantine area are used (Table 6). It is important to note that variable costs are not inclusive of land-associated costs (e.g., rent payments) or fixed costs associated with machinery and related equipment. Hence, fixed costs are unaffected by the decision not to plant.

Another group of growers who were in the process of preparing the land for planting and had incurred some or all of their variable costs may have also decided to stop planting after their land was encompassed in one of the 200-meter or one-half-mile areas. While the number of growers (and the associated acreage) falling into this category is likely to be very small, these growers would be facing losses equivalent to their expected gross revenues per acre.

The number of acres that will not be planted as a result of the outbreak is highly uncertain. As a reference, the USDA (USDA/NASS 2014) reports that in 2012 a total of 29,703 acres were in vegetable production in Miami-Dade County. To develop a rough estimate of the potential losses due to decisions to not plant, this analysis considers an optimistic non-planting rate of 0.5%. While a majority of these growers would decide not to plant before incurring any variable costs, we assume that 10% of them decide not to plant after variable costs have been incurred. The monetary loss associated with non-planting is quantified using the gross margin per acre calculated in Table 6, or $5,639.40 per acre for growers who decide not to plant before incurring variable costs and $10,722.60 for growers who decide not to plant after incurring variable costs. An example of a grower who decides not to plant after incurring variable costs is a tomato grower who had prepared the land and laid down protective plastic but had not yet placed seeds or seedlings in the field. In addition to the optimistic 0.5% non-planting rate, mid-range and pessimistic scenarios with 1% and 2% non-planting rates are also considered (Table 7).

Cost to State Government Agencies

FDACS is the main state agency establishing and enforcing the oriental fruit fly quarantine and eradication program in Florida. As part of the eradication effort, FDACS/DPI and the Office of Agricultural Law Enforcement personnel install and monitor fly traps in the area, establish a field operations center, and monitor the roadways to ensure that uncertified host material does not leave the quarantine area. In addition, FDACS also covers the costs of stripping and disposal of host material in the 200-meter area, as well as the purchase of the pesticide used in an aerial spray of the quarantine area. A majority of the costs are related to the salary, benefits, and travel expenses of the personnel required to monitor the quarantine (Table 8). The total costs for 79 days of quarantine are $1,540,958, or $19,506 per day. If no more flies were found and the quarantine ended on February 20, 2016, an additional $1,931,074 in expenses would be expected, bringing the estimated total cost to the agency at around $3,472,032. An additional $25,000 was spent by Miami-Dade County in hiring the helicopter that conducted the aerial spray, bringing costs to all agencies involved to an estimated $3,497,032.

Summary of Realized Losses

As of January 2016, growers in the production areas affected by the quarantine have lost an estimated $3,136,472. This estimate includes all areas that have been certified to be pre-harvest treated, and for which the treatment has been completed, as well as an estimate of the losses due to host product stripping and losses associated with postharvest treatment requirements. In addition, under the base scenario of 0.5% non-planting rate, an estimated $913,771 will also be lost due to non-planting of 148.52 acres of vegetables. Some of these grower losses may be mitigated by crop insurance payments; however, reliable

information on the extent of insured losses is unavailable. Total losses to growers in the optimistic scenario amount to $4,050,243. Accounting for costs of $1,565,958 to the state and local agencies involved in the response effort, the total costs of the oriental fruit fly outbreak rise to an estimated $5,616,192.

Alternative Cost Scenarios

While the estimates reported here represent the best available information to date, the oriental fruit fly outbreak is considered to be ongoing until eradication can be declared. If no additional flies are found, eradication will be considered achieved by February 20, 2016. It is likely that even if no additional flies are found, the total costs to growers will increase due to additional acreage requiring pre-harvest treatment. Also, while no flies have been found during the inspection period, additional finds are possible. To consider the total losses that are likely to result before the eradication campaign is complete, a mid-range and a pessimistic scenario are considered.

The mid-range scenario considered involves no additional fruit fly finds and implies no growth in the non-core quarantine area, one-half-mile area, or the 200-meter area. However, the production acreage subject to pre-harvest treatment increases fivefold as more product reaches harvest time. In this case, the total estimated losses increase to $8,858,751. The detailed results are shown in Table 9. In addition, an optimistic 1% non-planting rate would result in losses estimated at $1,827,542 due to the non-planting of 297 acres of vegetable crops. Therefore, under the mid-range scenario, total losses to growers would amount to an estimated $10,686,293. Accounting for costs of $3,497,032 to the state and local agencies involved brings the estimated costs of the oriental fruit fly outbreak to $14,183,325.

The pessimistic scenario considered involves a series of additional fly finds that result in a threefold increase in the size of the one-half-mile area and the 200-meter area. In addition, the production acreage in the non-core quarantine area increases tenfold from the optimistic scenario, or is twice as large as that from the mid-range scenario. In such a scenario, the total estimated losses would reach $19,423,405. The detailed results are shown in Table 10. In addition, a pessimistic 2% non-planting rate would result in losses estimated at $3,655,085 due to the non-planting of 594 acres of vegetable crops. Therefore, under the pessimistic scenario total losses to growers would amount to an estimated $23,078,490. In this scenario, we account for costs to the state agencies involved by assuming that the quarantine period would last an additional 100 days beyond February 20 2016, bringing the estimated costs to the state and local agencies to $5,422,611, and of the oriental fruit fly outbreak to $28,501,101.

Regional Economic Impacts

The total county economy impacts associated with grower losses due to the oriental fruit fly infestation were estimated using a regional economic model for Miami-Dade County constructed with the IMPLAN software and region data (Implan Group, LLC 2015). These estimates include the indirect and induced multiplier effects arising from changes in supply chain activity and employee household spending. The estimated values of direct losses to growers under the optimistic, mid-range, and pessimistic scenarios were entered in the model in the fruit farming, vegetable farming, and nursery and greenhouse industry sectors. The grower losses were assumed to represent a change in final demand in the county. Results are presented in Table 11. For the optimistic scenario, total industry output impacts were estimated at $10.2 million, value added (GDP) impacts were $7.2 million, labor income impacts (employee compensation and proprietor income) were $4.5 million, and employment impacts were 124 (full-time and part-time) jobs. For the mid-range scenario, impacts were estimated at $27 million in output, $18.9 million in GDP, $11.9 million in labor income, and 334 jobs. For the pessimistic scenario, impacts were estimated at $58.5 million in output, $40.9 million in GDP, $25.8 million in labor income, and 726 jobs. Note that these impact measures are independent and should *not* be added together.

Conclusions

The direct losses to growers as a result of the current outbreak of the oriental fruit fly in Miami-Dade County are estimated to be $3,136,472. This estimate is inclusive of the additional pesticide bait sprays required as part of the pre-harvest treatment, losses of 98% of product in areas required to follow postharvest treatment, and complete losses of product in areas subject to fruit stripping. In addition, a 0.5% non-planting rate for vegetable crops in Miami-Dade County would result in an estimated loss of $913,771. The total grower direct loss in the optimistic scenario of realized losses is therefore $4,050,243, with an additional $1,565,958 in costs to state and local agencies. The total regional impact was estimated at $10.2 million in output and 124 jobs.

Additional mid-range and pessimistic scenarios were also considered. The mid-range scenario involves no additional fruit fly finds, but considers a fivefold increase in the

production acreage subject to pre-harvest treatments as commodities get closer to harvest time. In this scenario, the total losses to growers amount to $8,858,751. In addition, the non-planting of 297 acres of vegetables would result in losses estimated at $1,827,542. The total direct grower losses in the mid-range scenario are estimated at $10,686,293, with an additional $3,497,032 in costs to state and local agencies. The total regional impact was estimated at $27 million in output and 334 jobs.

In the pessimistic scenario, a threefold increase in the 200-meter and one-half-mile areas is considered. Such an increase would be the result of additional female or larval finds. In addition, this scenario considers a tenfold increase in the production acreage subject to pre-harvest treatment as a result of a lengthened quarantine period. In such a scenario, the total estimated losses to growers reach $19,423,405. In addition, the non-planting of 594 acres of vegetables would result in estimated losses of $3,655,085. The total direct grower losses in the pessimistic scenario are estimated at $23,078,490, with an additional $5,422,611 in costs to state and local agencies. The total regional impact was estimated at $58.5 million in output and 726 jobs.

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Table 1. Total acreage in each of the three areas under quarantine

Section	Acres	Square Miles	Proportion
Quarantine Area	63,136.46	98.65	0.95
One-Half-Mile Area	2,955.46	4.62	0.04
200-Meter Area	512.26	0.8	0.01
Source: FDACS/DPI unpublished records.			

Table 2. Acreage wtih completed pre-harvest treatments by commodity in oriental fruit fly quantine area

Commodity	Acres with Completed Pre-Harvest Treatment
Avocado	1,751.65
Bean	498.00
Squash	205.00
Banana	150.01
Papaya	139.85
Mamey	133.75
Dragon fruit	107.95
Longans	78.00
Eggplant	40.25
Passion fruit	38.80
Guava	38.25
Melon	27.00
Citrus	26.00
Coconut	24.00
Mango	20.50
Tree farm	20.00
Palms	17.00
Carambola	17.00
Peppers	16.75
Tomato	16.00
Sapodilla	8.00
Annona	6.50
TOTAL	*3,380.26*
Source: FDACS/DPI unpublished records.	

Table 3. Assumed proportions of the agricultural production acreage falling in each of the three areas under quarantine

Parameter	Value
Proportion in 200-meter area	0.02
Proportion in one-half-mile area	0.05
Proportion in non-core quarantine area	0.93

Table 4. Affected acreage by commodity in three areas under quarantine

Commodity	Treated Acres in Non-Core Quarantine Area	Acres in 200-Meter Area	Acres in 1/2-Mile Area	Total Affected Acreage
Avocado	1,751.65	37.67	94.17	1,883.49
Bean	498.00	10.71	26.77	535.48
Squash	205.00	4.41	11.02	220.43
Banana	150.01	3.23	8.07	161.30
Papaya	139.85	3.01	7.52	150.38
Mamey	133.75	2.88	7.19	143.82
Dragon fruit	107.95	2.32	5.80	116.08
Longans	78.00	1.68	4.19	83.87
Eggplant	40.25	0.87	2.16	43.28
Passion fruit	38.80	0.83	2.09	41.72
Guava	38.25	0.82	2.06	41.13
Melon	27.00	0.58	1.45	29.03
Citrus	26.00	0.56	1.40	27.96
Coconut	24.00	0.52	1.29	25.81
Mango	20.50	0.44	1.10	22.04
Tree farm	20.00	0.43	1.08	21.51
Palms	17.00	0.37	0.91	18.28
Carambola	17.00	0.37	0.91	18.28
Peppers	16.75	0.36	0.90	18.01
Tomato	16.00	0.34	0.86	17.20
Sapodilla	8.00	0.17	0.43	8.60
Annona	6.50	0.14	0.35	6.99
TOTAL	*3,380.26 (93%)*	*72.69 (2%)*	*181.73 (5%)*	*3,634.69 (100%)*

Table 5. Total estiamged direct financial losses by commodity to growers in three areas of quantine zone

Commodity	Losses from Non-Core Quarantine Area ($)	Losses from 200-Meter Area ($)	Losses from 1/2-Mile Area ($)	Total Losses ($)
Avocado	603,181	192,682	472,070	1,267,932
Dragon fruit	148,010	59,547	145,889	353,446
Bean	144,069	42,988	105,320	292,376
Squash	86,553	29,415	72,067	188,034
Mamey	75,850	55,054	67,441	198,345
Papaya	75,323	27,068	66,316	168,707
Banana	62,063	20,977	51,394	134,434
Longans	57,367	21,702	53,169	132,238
Carambola	45,876	19,084	46,755	111,716
Tomato	21,466	8,623	21,126	51,215
Guava	18,393	6,453	15,810	40,656
Passion fruit	17,806	6,180	15,141	39,128
Eggplant	16,949	5,756	14,103	36,808
Peppers	11,534	4,323	10,590	26,447
Coconut	11,014	3,823	9,366	24,203
Mango	7,956	2,641	6,470	17,067
Melon	7,288	2,106	5,159	14,553
Citrus	6,238	1,692	4,146	12,077
Tree farm	3,772	860	2,108	6,740
Sapodilla	3,671	1,274	3,122	8,068
Palms	3,206	731	1,791	5,729
Annona	2,983	1,035	2,537	6,555
TOTAL	*$1,430,570*	*$514,012*	*$1,191,890*	*$3,136,472*

Table 6. Net returns per acre for select annual crops in quarantine zone

Annuals	Gross Revenues per Acre	Variable Costs per Acre	Gross Margin per Acre
Bean	$3,230.00	$2,208.00	$1,022.00
Squash	$6,672.00	$2,642.00	$4,030.00
Eggplant	$6,650.00	$5,014.00	$1,636.00
Pepper	$12,000.00	$8,864.00	$3,136.00
Tomato	$25,061.00	$6,688.00	$18,373.00
AVERAGE	*$10,722.60*	*$5,083.20*	*$5,639.40*

Table 7. Estimated losses due to non-planting of vegetables under several non-planting rates

Non-Planting Rate (%)	Acres Not Planted	Loss of Net Profit
0.2	59.41	$365,508
0.5	148.52	$913,771
1.0	297.03	$1,827,542
2.0	594.06	$3,655,085

Table 8. Total costs to FDACS

Expense	Amount
Salary and benefits	$825,296
Travel-related expenses	$365,372
Fuel	$22,680
Outreach and educational materials	$53,737
Pesticide and other treatment costs	$177,843
Vehicles maintenance and repairs	$11,582
Contract for stripping fruit	$65,799
Disposal of stripped fruit	$18,649
Total (by 11/13/2016)	$1,540,958
Daily expenses	$19,506
Expected total cost (by 2/21/2016)	$3,472,032
Source: FDACS/DPI unpublished records.	

Table 9. Total financial losses and affected acreage under the mid-range scenario

Commodity	Losses from Non-Core Quarantine Area ($)	Losses 200-Meter Area ($)	Losses from ½-Mile Area ($)	Total Losses ($)	Treated Acres in Non-Core Quarantine Area	Acres in 200-Meter Area	Acres in ½-Mile Area	Total Affected Acreage
Avocado	3,015,903	192,682	472,070	3,680,655	8,758.25	37.67	94.17	8,890.09
Dragon fruit	740,051	59,547	145,889	945,487	539.75	2.32	5.80	547.88
Bean	720,345	42,988	105,320	868,652	2,490.00	10.71	26.77	2,527.48
Squash	432,764	29,415	72,067	534,246	1,025.00	4.41	11.02	1,040.43
Mamey	379,251	55,054	67,441	501,745	668.75	2.88	7.19	678.82
Papaya	376,616	27,068	66,316	470,000	699.25	3.01	7.52	709.78
Banana	310,314	20,977	51,394	382,686	750.05	3.23	8.07	761.34
Longans	286,835	21,702	53,169	361,706	390.00	1.68	4.19	395.87
Carambola	229,381	19,084	46,755	295,220	85.00	0.37	0.91	86.28
Tomato	107,330	8,623	21,126	137,080	80.00	0.34	0.86	81.20
Guava	91,963	6,453	15,810	114,226	191.25	0.82	2.06	194.13
Passion fruit	89,032	6,180	15,141	110,353	194.00	0.83	2.09	196.92
Eggplant	84,746	5,756	14,103	104,605	201.25	0.87	2.16	204.28
Peppers	57,670	4,323	10,590	72,583	83.75	0.36	0.90	85.01
Coconut	55,071	3,823	9,366	68,260	120.00	0.52	1.29	121.81
Mango	39,780	2,641	6,470	48,891	102.50	0.44	1.10	104.04
Melon	36,440	2,106	5,159	43,705	135.00	0.58	1.45	137.03
Citrus	31,192	1,692	4,146	37,031	130.00	0.56	1.40	131.96
Sapodilla	18,357	1,274	3,122	22,753	40.00	0.17	0.43	40.60
Tree farm	18,860	860	2,108	21,828	100.00	0.43	1.08	101.51
Palms	16,031	731	1,791	18,554	85.00	0.37	0.91	86.28
Annona	14,915	1,035	2,537	18,487	32.50	0.14	0.35	32.99
TOTAL	*$7,152,849*	*$514,012*	*$1,191,890*	*$8,858,751*	*16,901.30*	*72.69*	*181.73*	*17,155.73*

Table 10. Total financial losses and affected acreage under the pessimistic scenario

Commodity	Losses from Non-Core Quarantine Area ($)	Losses from 200-Meter Area ($)	Losses from ½-Mile Area ($)	Total Losses ($)	Treated Acres in Non-Core Quarantine Area	Acres in 200-Meter Area	Acres in ½-Mile Area	Total Affected Acreage
Avocado	6,031,807	578,045	1,416,209	8,026,060	17,516.50	113.01	282.52	17,912.03
Dragon fruit	1,480,102	178,640	437,668	2,096,410	1,079.50	6.96	17.41	1,103.88
Bean	1,440,689	128,963	315,959	1,885,610	4,980.00	32.13	80.32	5,092.45
Squash	865,528	88,245	216,200	1,169,973	2,050.00	13.23	33.06	2,096.29
Mamey	758,502	165,161	202,322	1,125,985	1,337.50	8.63	21.57	1,367.70
Papaya	753,232	81,203	198,948	1,033,383	1,398.50	9.02	22.56	1,430.08
Banana	620,629	62,932	154,182	837,743	1,500.10	9.68	24.20	1,533.97
Longans	573,671	65,105	159,507	798,282	780.00	5.03	12.58	797.61
Carambola	458,762	57,252	140,266	656,280	170.00	1.10	2.74	173.84
Tomato	214,661	25,869	63,379	303,909	160.00	1.03	2.58	163.61
Guava	183,925	19,359	47,431	250,715	382.50	2.47	6.17	391.14
Passion fruit	178,064	18,540	45,424	242,028	388.00	2.50	6.26	396.76
Eggplant	169,493	17,269	42,308	229,069	402.50	2.60	6.49	411.59
Peppers	115,341	12,968	31,771	160,079	167.50	1.08	2.70	171.28
Coconut	110,143	11,468	28,097	149,708	240.00	1.55	3.87	245.42
Mango	79,561	7,922	19,410	106,892	205.00	1.32	3.31	209.63
Melon	72,881	6,317	15,477	94,675	270.00	1.74	4.35	276.10
Citrus	62,384	5,077	12,439	79,901	260.00	1.68	4.19	265.87
Sapodilla	36,714	3,823	9,366	49,903	80.00	0.52	1.29	81.81
Tree farm	37,720	2,581	6,323	46,623	200.00	1.29	3.23	204.52
Annona	29,830	3,106	7,610	40,546	65.00	0.42	1.05	66.47
Palms	32,062	2,194	5,374	39,630	170.00	1.10	2.74	173.84
TOTAL	*$14,305,699*	*$1,542,037*	*$3,575,669*	*$19,423,405*	*33,802.60*	*218.08*	*545.20*	*34,565.88*

Table 11. Summary of regional economic impacts associated with grower damages from oriental fruit fly infestiona in Miami-Dade County, FL

Impact Scenario	Impact Type	Employment (fulltime and part-time jobs)	Labor Income (employee compensation, proprietor income)	Value Added (Gross Domestic Product)	Industry Output (sales revenues)
Optimistic	Direct Effect	74.4	$2,191,768	$3,407,074	$4,050,243
	Indirect Effect	6.9	$229,629	$364,202	$548,701
	Induced Effect	42.2	$2,065,908	$3,387,753	$5,632,053
	Total Effect	123.5	$4,487,305	$7,159,029	$10,230,997
Mid-range	Direct Effect	203.7	$5,849,278	$8,995,124	$10,686,293
	Indirect Effect	18.3	$608,118	$962,693	$1,449,370
	Induced Effect	111.8	$5,472,370	$8,974,394	$14,917,818
	Total Effect	333.9	$11,929,766	$18,932,211	$27,053,481
Pessimistic	Direct Effect	444.3	$12,671,147	$19,430,421	$23,078,491
	Indirect Effect	39.7	$1,314,481	$2,079,909	$3,130,756
	Induced Effect	241.8	$11,831,196	$19,402,862	$32,251,601
	Total Effect	725.8	$25,816,824	$40,913,192	$58,460,848

Source: IMPLAN model for Miami-Dade County, FL, 2013 (release 3), with trade flows specification (Implan Group LLC, 2015).