The Social Cost of Managing Invasive Species: The Case of Citrus Greening

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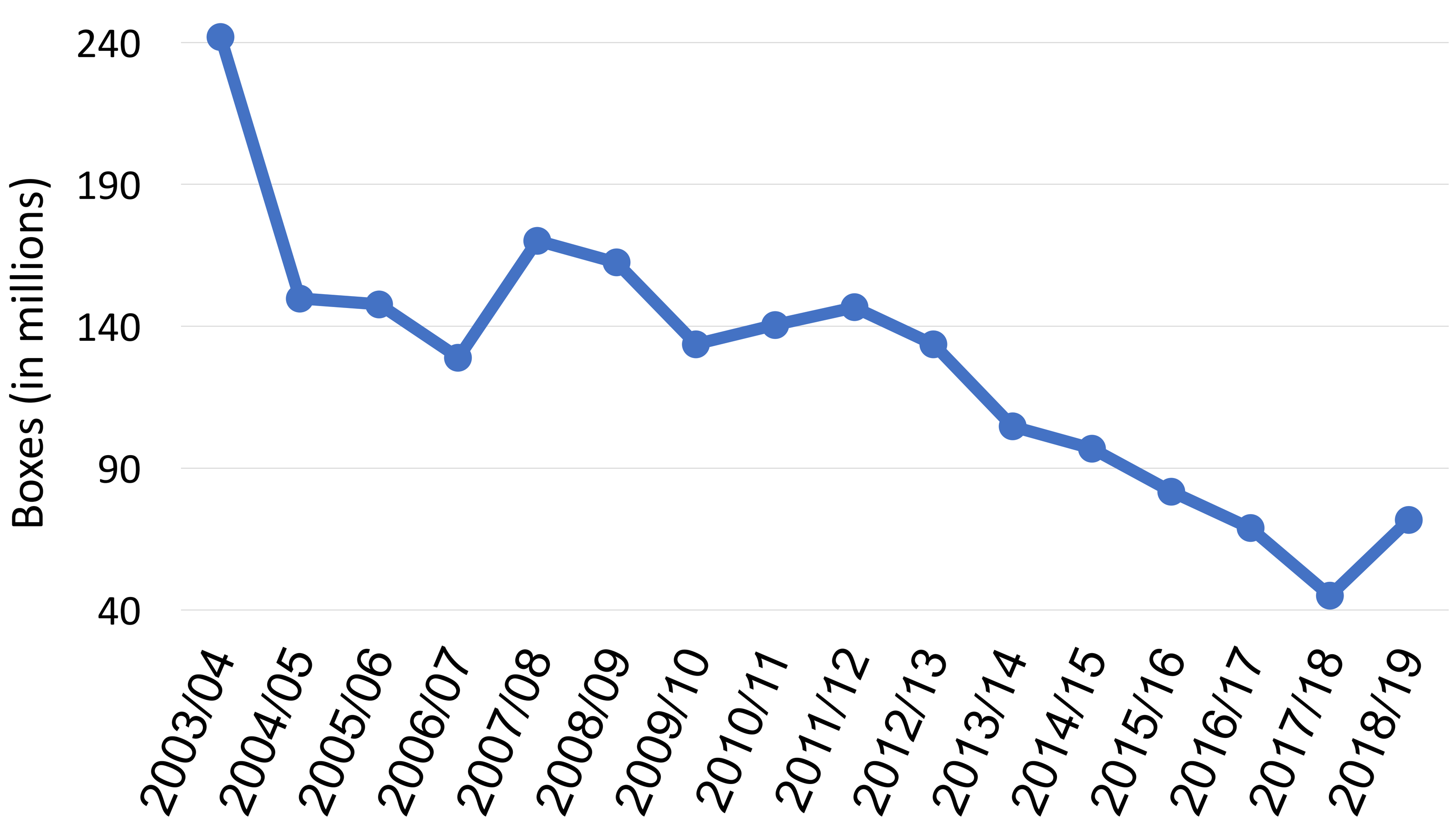
1 – Introduction

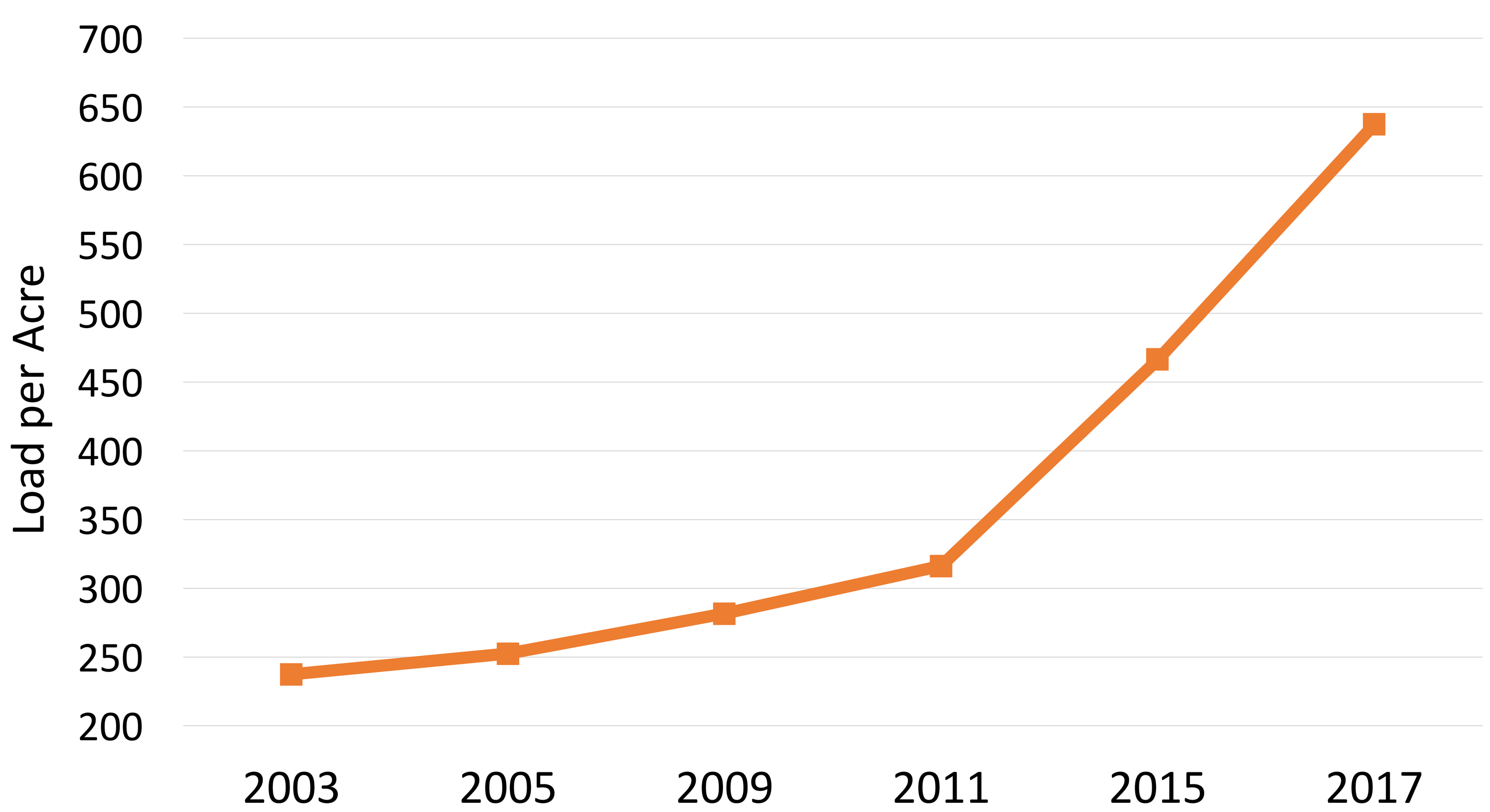
- Since citrus greening — a bacterial disease transmitted by the Asian citrus psyllid (ACP) — was found in Florida, orange production statewide has decreased by 74% (Fig 1).

Figure 1: Orange Production in Florida



- To mitigate losses, growers have adopted an intensive insecticide program to control the ACP population.
- While such practice helps control the spread of the disease, it generates negative externalities. Thus, growers' pest control decisions have wide-ranging impacts beyond their own farm.
- The load per area indicator incorporates the multiple externalities associated with chemical use. In Florida, the toxicity of insecticides used per acre increased almost three-fold since greening was found (Fig. 2).

Figure 2: Toxicity of Insecticide Use for Oranges in Florida



2 – Objective

We simulate the profit maximizing problem of a representative citrus grower to quantify the differential impact of implementing a tax policy on insecticide use that accounts for their externalities (i.e., toxicity) relative to a tax on quantity.

3 – Data and Methods

- Used historical yield and price data for Valencia oranges to generate correlated random draws.
- Used data from the International Union of Pure and Applied Chemistry database to compute the toxicity of each insecticide used on oranges in Florida.
- Modeled a damage function that also incorporates the ACP kill rate of insecticides. For parametrization we followed references from the biological literature.
- Simulated the profit maximization of a representative citrus grower in Florida under different scenarios including: (1) a baseline with no tax, (2) load (toxicity) tax, (3) a quantity tax.

Representative Citrus Grower Profit Function for Load Tax Scenario:

$$E(\pi) = \tilde{P}\cdot\tilde{Y}\left(1-\frac{\theta\cdot N_0(I)}{1+\frac{\theta\cdot N_0(I)}{\eta}}\right)-\sum_i (w_i + L_i\cdot\tau)\cdot I_i - \bar{C}$$

$\tilde{P}$: Price of Valencia oranges in Florida

$\tilde{Y}$: Maximum potential yield in absence of ACP

θ: Slope of rectangular hyperbola at origin

η: Rectangular hyperbola horizontal asymptote

N_0: ACP population

I_i: Use of insecticide i

w_i: Cost of insecticide I

L_i: Load of insecticide i

$\bar{C}$: Average cost of production not related to insecticides

τ: Load tax rate

4 – Results

		Load Tax			Quantity Tax		
ACP Level	Tax rate ($)	% Load reduction	Avg. % Yield reduction	Avg. % Profit reduction	% Load reduction	Avg. % Yield reduction	Avg. % Profit reduction
10	0.25	-77.01	-0.85	-4.99	-3.80	-0.05	-0.43
20		-85.32	-4.34	-22.29	-0.74	-0.05	-0.94
30		-70.84	-5.04	-40.86	-0.02	-0.02	-1.16
40		-51.17	-3.87	-55.03	0.00	0.00	-1.27
10	0.50	-85.17	-1.36	-7.96	-7.78	-0.09	-0.86
20		-89.60	-4.87	-27.87	-1.98	-0.19	-1.90
30		-88.00	-6.83	-51.79	-0.06	-0.06	-2.33
40		-84.16	-7.10	-74.31	0.00	0.00	-2.55
10	10	-100.00	-3.51	-14.27	-86.93	-2.18	-11.80
20		-99.99	-10.52	-53.93	-51.07	-3.97	-32.36
30		-99.98	-15.11	-98.82	-23.20	-2.93	-44.64
40		-99.93	-17.53	-141.77	-9.51	-1.57	-51.71

5 – Conclusions

- We found that even a modest tax on the toxicity (Load) of insecticides would contribute to significantly reduce their use and social cost.
- Given the significant impact such a tax has on the grower's yield and profit, the approach could be used by policymakers to encourage growers to adopt area-wide pest management by making coordinated sprays exempt from the tax.