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Externalities Associated with Imported Spinach Seeds

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Externalities Associated with Imported Spinach Seeds

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Objectives

What is the magnitude of the loss experienced by California lettuce growers as a result of Verticillium wilt?

- Model an externality problem with a middleman who doesn't care
- Model and simulate lettuce losses
- Compare joint profit maximization solution with different property rights assignment schemes
- Initially a problem of available technology, now an issue of cooperation

Introduction

Lettuce is an important crop in California and Monterey County specifically. The externality imposed by spinach seed contamination may be substantial.

- $1.4 billion lettuce grown in California in 2012, much of it in Monterey and Santa Cruz counties
- *Verticillium dahliae* affects hundreds of plant species, causing Verticillium wilt
- First detected in lettuce in the Pajaro Valley in California in 1995
- By 2010, more than 175 fields were infected with Verticillium wilt, amounting to nearly 4,000 acres
- No control method is available once plants are affected
- Fungus mainly enters fields carried on spinach seeds

Data

- Pesticide Use Reporting (PUR) data for Monterey County, California from the California Department of Pesticide Regulation
  - All fields on which a pesticide was applied from 1993 to 2011
  - I create a monthly data set consisting of unique fields
- Crop price and yield data from the Monterey County Agricultural Commissioner's Office
- Rainfall and temperature data from the National Weather Service

Method

- Spinach seed producers and owners are not affected by the disease and have no incentive to prevent or mitigate the externality
- I use vertical integration to model the internalization of the externality
- Simulate a field on which spinach and lettuce are grown for ten crop cycles
- Random variables for spinach seed infection rate and microsclerotia production rate with mean and standard deviation from plant pathologists
- Key parameters: survival rate of microsclerotia, number of microsclerotia carried per spinach seed, and infection rate of lettuce seeds
- Run each simulation 1000 times

Results

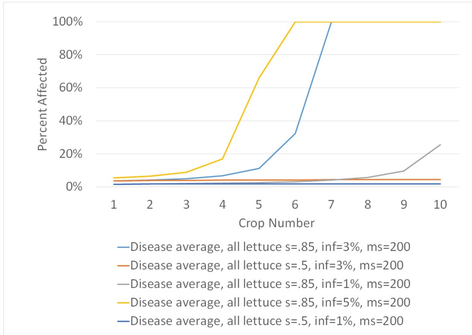

Figure 1: Continuous Lettuce Cropping

- In a typical cropping pattern of spinach, lettuce, lettuce, varying the parameters has little impact
- Even with simple simulations, the externality is quite large, especially when subsequent seasons are considered
- Reducing the spinach seed infection rate (internalizing the externality) will mitigate damages
- High microsclerotia survival rate is very damaging
- Microsclerotia levels rise rapidly past the threshold for lettuce disease in all cases when lettuce is cropped continuously
- Importantly, the infection rate of lettuce has little impact in a mixed rotation
- Planting just one crop of spinach greatly increases disease incidence, especially in the initial periods

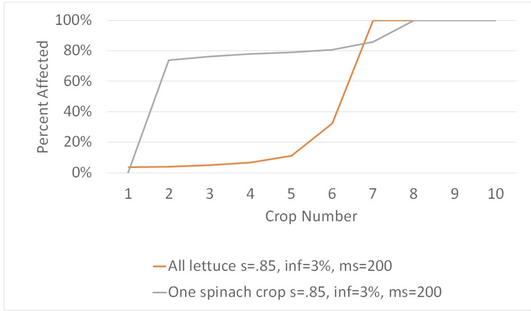

Figure 2: One Spinach Crop Makes a Big Difference

Conclusion

Figure 3: Verticillium wilt

- In the all lettuce scenario, the first 6 crops can be harvested, the last 4 are lost
- With just one crop of spinach, losses average 86%
- Total growing cost for lettuce (excluding harvest) is $4,102 per acre according to the UC Cooperative Extension; these inputs are lost when the crop cannot be harvested

References

[1] John Rust. Optimal replacement of GMC bus engines: An empirical model of harold zurcher. *Econometrica: Journal of the Econometric Society*, 55(5):999–1033, 1987.

Future Research

I will use simulations to generate data on the effects of different control methods.
This model does not account for unobserved heterogeneity among growers or the possibility of risk aversion. Future work will test for and incorporate these features.

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