Economics of plant disease management using Technological Innovation

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Economics:

the study of
the optimal allocation of resources
to maximize the welfare of people.

Goals of Economic Analysis of Emerging Technology

1. Characterize / Derive preferred implantation(s) of technology in evolved/new production systems

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     for industry and policy leaders, …

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     for producers, agribusinesses, technology vendors, …

   - **At the industry, region, market level**
     for industry policy leaders re. outbreak control strategy, …

   - **At the national and global level**
     for food security, sustainability, and other policy leaders

Goals of Economic Analysis of Emerging Technology

2. Characterize the range of costs and benefits under various implementations of technology in current and new production systems

build a realistic, function based model that captures critical biological and physical relationships of the production system and technology

Goals of Economic Analysis of Emerging Technology

3. Provide R&D team with value driven needs for new data to strengthen model and recommendations

4. Provide R&D team with direction for further development of the technology to create additional value in implementation.

ESTIMATED TOMATO PRODUCTION COSTS PER ACRE
(Marketable Yield = 77,317 pounds, or 3,093 25lb boxes)

Month	Type of Operation	Equipment Costs	Materials Costs	Labor Costs	Total Costs	Your Costs
February						
	Attend Grower Meetings	0.00	250.00	40.68	290.68	
Total February		**$0.00**	**$250.00**	**$40.68**	**$290.68**	
March						
	Plow Field	16.72	0.00	11.19	27.91	
	Disc Field	8.83	0.00	5.59	14.42	
	Subsoil Field	20.29	0.00	15.25	35.55	
Total March		**$45.84**	**$0.00**	**$32.04**	**$77.87**	
April						
	Preplant Fertilizer	10.53	127.50	7.63	145.66	
	Assemble Irrigation System	12.08	0.00	84.75	96.83	
	Bedding and Fumigation	204.91	990.00	30.51	1,225.41	
Total April		**$227.51**	**$1,117.50**	**$122.89**	**$1,467.90**	
May						
	Purchase Plugs	0.00	550.00	8.47	558.47	
	Fertilize Plugs	0.11	0.83	8.47	9.42	
	Transplant Plugs	53.46	0.00	40.68	94.14	
	Replant 2%	0.00	11.00	8.47	19.47	
	Drip Irrigation	580.79	210.60	525.45	1,316.83	
	Staking	0.00	550.00	52.50	602.50	
	String x2	0.00	9.90	34.80	44.70	
	Prune	0.00	0.00	47.85	47.85	
	Weekly Sprays	38.85	266.43	22.37	327.65	
	Post-Emergent Herbicide	7.75	13.78	5.59	27.11	
Total May		**$680.95**	**$1,612.54**	**$754.67**	**$3,048.16**	
June						
	Drip Irrigation	562.05	210.60	508.50	1,281.15	
	Weekly Sprays	38.85	312.05	22.37	373.27	
	Post-Emergent Herbicide	7.75	17.75	5.59	31.08	
Total June		**$608.64**	**$540.40**	**$536.46**	**$1,685.50**	
July						
	Drip Irrigation	580.79	210.60	525.45	1,316.83	
	Weekly Sprays	38.85	150.55	22.37	211.76	
	Harvest	0.00	0.00	9,278.02	9,278.02	
Total July		**$619.63**	**$361.15**	**$9,825.84**	**$10,806.61**	
October						
	Remove Plastic	46.64	0.00	152.55	199.19	
	Dispose Plastic	16.15	0.00	10.17	26.32	
	Disk Field	16.05	0.00	10.17	26.22	
	Apply Lime	0.00	55.00	0.00	55.00	
	Plant Rye for Cover Crop	16.99	17.00	10.17	44.16	
Total October		**$95.83**	**$72.00**	**$183.06**	**$350.89**	
Annual Administrative Costs						
	Real Estate Taxes	0.00	16.00	0.00	16.00	
	Management Fee	0.00	10.00	0.00	10.00	
	Net Land Rent	0.00	100.00	0.00	100.00	
	Miscellaneous	0.00	35.00	0.00	35.00	
	Internet service	0.00	40.00	0.00	40.00	
	Overhead (Utilities, legal fees, etc.)	0.00	25.00	0.00	25.00	
Total Annual Administrative Costs		**$0.00**	**$226.00**	**$0.00**	**$226.00**	
Seasonal Costs						
	1/2 Ton Pick-up	32.30	0.00	20.34	52.64	
	Operating Capital	0.00	70.00	0.00	70.00	
Total Seasonal Costs		**$32.30**	**$70.00**	**$20.34**	**$122.64**	
TOTAL ANNUAL COSTS		**$2,310.71**	**$4,249.58**	**$11,515.96**	**$18,076.25**	

A Tomato Enterprise Budget (NCSU)

An example product of modeling

Noteable:

Total Cost ~ $18,000 / acre / year

Weekly Spray Costs

~ $911 / acre /year

Limitations:

Not intended as actual

Ignores variability / risk

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Critical Features of Emerging Plant Disease Management Technology

1. Characterize variability in the production system

   What are the probabilities of different levels of yield (quantity x quality) ?

   What external factors drive yield variability (function)?

   How do input / management decisions affect yield variability (function)?

Critical Features of Emerging Plant Disease Management Technology

2. Characterize plant behavior as a probabilistic function of external and internal variables

3. Characterize pathogen behavior and effects on the plant (individual and population) as a prob. function of other variables

4. Characterize new technology behavior as a prob. function of technology deployment, and other variables.
(select a range of deployments to map costs vs.benefits)

An Example of Economic Analysis of Emerging Plant Disease Management Technology

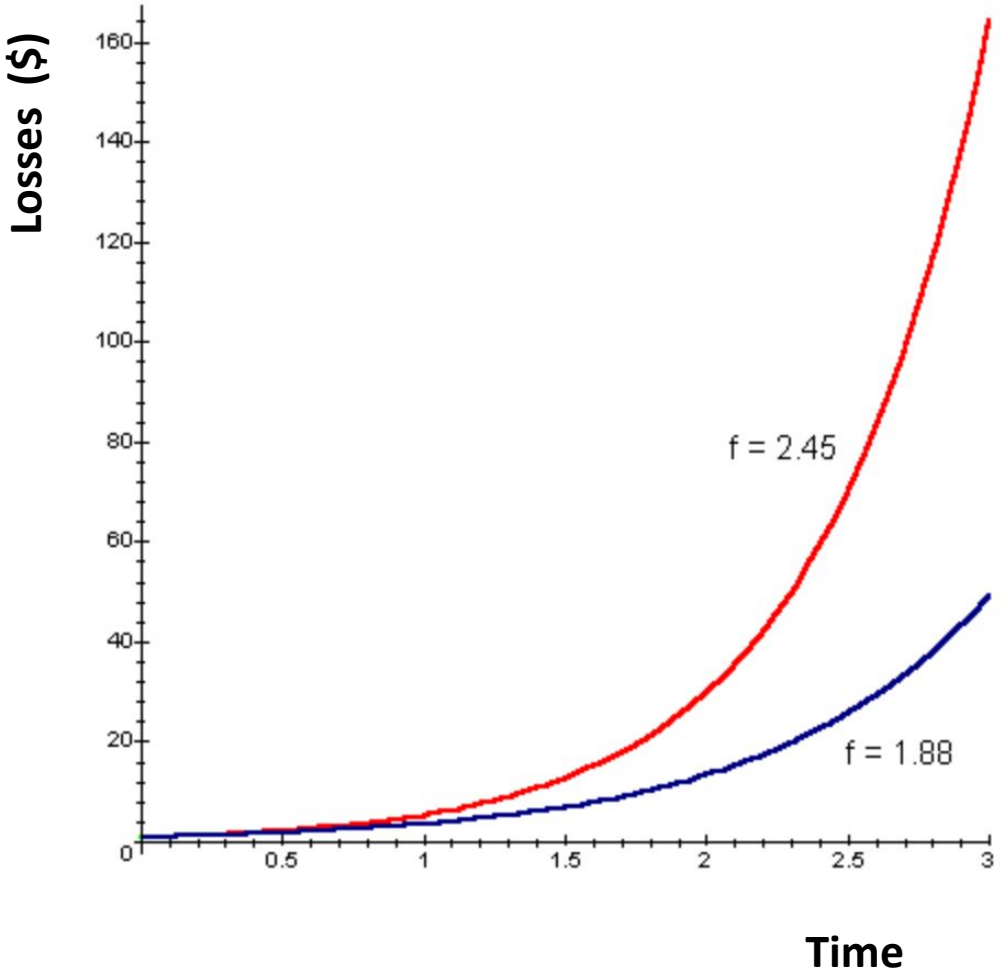
Liu et al. 2018 compared effects of a regular spray program to a spray program based on a decision support system (DSS) for Late Blight in Field tomatoes.

Ignoring Yield differences DSS generated net benefits of -$28 to +$48 per acre

With yield differences based on plot tests, DSS generated estimated net benefits of $496 to $1714 per acre. (Ranges represent values across 3 levels of susceptibility in cultivars).

Yangxuan Liu, Michael R. Langemeier, Ian M. Small, Laura Joseph, William E. Fry, Jean B. Ristaino, Amanda Saville, Benjamin M. Gramig, Paul V. Preckel. A Risk Analysis of Precision Agriculture Technology to Manage Tomato Late Blight. Sustainability 2018. 10. 3108. 19 pages.

Benefits of Early Intervention in Disease Outbreaks



Losses grow rapidly as time passes

Rate depends on characteristics of the pathogen, vectors, distances, and other factors

Given early detection, and depending on efficacy of available treatments,

- market or regional level losses can be capped or limited

Depending on costs of treatments, costs of early intervention may be very small compared to value of losses avoided.

Regional action may require established policy and readiness, logistics and funding mechanisms.

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Social Benefits of Emerging Plant Disease Management Technology

Reduced release of protection chemicals into the environment

Increased Yield and Reduced Resource Consumption

Regional economy stability in processing and other sectors

Increased food security and improved consumer welfare

Summary

Economic analysis of Emerging Plant Disease Management Technology:

- **informs beneficial adoption and policy**
- **identifies value of needed data**
- **identifies value of further R&D**

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