Optimal Control of Potato Virus Y: Policy Recommendations for the San Luis Valley of Colorado

Submitted to:
Colorado Potato Administrative Committee

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TITLE OF PROPOSAL Optimal Control of Potato Virus Y: Policy Recommendations for the San Luis Valley of Colorado.

FUNDING SOURCE Colorado Potato Administrative Committee (CPAC)

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NATURE, SCOPE, AND OBJECTIVES

The various strains of potato virus Y (PVY) have been shown to be an important pathogen with potential to reduce both yields and tuber quality, resulting in significant bottom-line impact to potato producers in the Western United States (Agro Engineering, 2007). As PVY is transmitted via aphid populations and through planting tubers harvested from infected plants, the infection problem is characterized by what might be termed stochastic externalities, in that the management practices of one producer may, given the realized state of nature, ultimately affect (and infect) nearby producers. As producers often decide to retain tubers for planting in subsequent seasons, rather than opting for certified seed (approximately 68% on average), the management problem is also dynamic in nature, as decisions in any one time period are linked with future decisions and disease spread (Davidson, Sather, and Haslar, 2007). The fact that visible symptoms of infection are not easily recognized in certain species, such as the popular Russet Norkotah, tends to exacerbate the use of non-certified seed, and thus the risk of aphid-driven infection (Agro Engineering, 2007).

Effective mitigation of PVY is dependent upon regional producers adopting sound management practices and potentially supporting legislation to overcome "free-rider" problems. As such, we proposed to conduct both a data collection exercise that will provide greater representation of PVY spread in Colorado and to create a dynamic, bio-economic model to conduct cost/benefit evaluations of policies under consideration to control PVY infection. Policies to be evaluated include the mandatory use of certified seed and/or increased insecticide application among others. The planned project length is one year.

Objectives

- Collect in-field detection and validation excersises on at least 6 representative potato fields to parameterize the model and augment the limited data that is available on aphid populations, PVY infection rates, and yields.

- Create a dynamic, bioeconomic model that is capable of conducting detailed cost/benefit evaluations of policies to control infection from PVY.
- Dissemenate results on a large scale to Colorado potato producers including CPAC and CCPGA members, and to legislative bodies.
- Leverage research findings to fund additional regional and national research projects.

METHODS AND FACILITIES

Data collection will be accomplished through in-field detection and validation exercises. Soil biology, management practices, and other ecosystem variables can differ significantly in an area as diverse as the San Luis Valley and information on PVY spread is not currently collected for commercial (non-certified seed) acres. Therefore, a primary data collection exercise is needed to parameterize our model while also providing valuable information to commercial potato producers. Dr. Dan Manter of USDA-ARS, in cooperation with Bill Crowder of AgroEngineering, will collect data on rates of PVY infection, aphid populations, and yields from approximately 6 representative (center pivot irrigated) potato fields planted with certified and non-certified seed. PVY detection will be accomplished using an RT-PCR based survey, which is capable of detecting and differentiating between various PVY strains. PVY surveys will be conducted at planting (seed), at least twice during the growing season (leaves), and at harvest (tubers).

Once data is collected, our dynamic, bioeconomic model of PVY spread will be customized to account for the biological and managerial relationships that define the potato production ecosystem in the San Luis Valley. A similar model was developed for optimal control of potato leafroll virus driven by predicted aphid population dynamics (Marsh, Juffaker and Long, 2000). While this paper allowed for dynamic vector-virus-plant interactions, it lacks several components that influence PVY spread. For example, it ignores stochastic externalities and the impact of mangement practices of neighboring producers on bordering plots. Furthermore, the paper assumed that that PVY was spread soley by aphids, however, PVY infection may also occur as a result of vectorless plant-to-plant spread. As such, the use of insecticides will not fully control PVY outbreaks (Agro Engineering, 2007).

Our modeling approach will combine the methodologies of the Marsh, Juffaker, and Long, 2000 and Heikkila and Peltola, 2004 studies. Specifically, our model will allow for the evaluation of region-wide, rather than individual-based, management systems for PVY and account for the dynamic environment in which potato production occurs. Similar to the model in Marsh, Juffaker, and Long (2000), aphid populations will be modeled as a function of degree days; however, we will also make efforts to model the population size as a function of management practices including insecticide applications. Benefits and costs of several management options, including current individual-based strategies without specific policy action, a mandatory certified seed program of various forms, and other potentially feasible programs of PVY control will be considered. Dr. Craig Bond and Jennifer Keeling Bond of CSU will parameterize, build, and solve the model, as well as analyze and disseminate the results.

Much of the research will take place "in the field" on 6 fields to be selected by Bill Crowder and Dan Manter. Analysis of collected data and model building will take place on the Colorado State University campus in Fort Collins.

RELATIOSHIP OF RESEARCH TO PROPOSED PROBLEM

In light of current industry-lead efforts to affect state legislation requiring the use of certified potato seed to reduce PVY-related losses, this study seeks to provide producers and legislators with accurate information about the cost and benefits of PVY-control and policy in the major potato growing region of Colorado. PVY problems in Colorado are said to have reached "epidimic" levels and other states are stuggling with PVY-related yield losses (Ehrlich, 2007). As such, the proposed research, which may be generalized to other potato growing regions, is both timely and essential to inform PVY mitigation efforts.

LEVERAGE POTENTIAL

In a recent Spudman article, Dr. Stewart Gray of the USDA-ARS's Plant Protection Research Unit stated "(PVY) spreads rapidly and can have dramatic impacts on yield and quality." Furthermore, the article stated that "PVY threatens not only potatoes but other crops such as tomato, pepper, and tobacco." Given the difficulty of controlling PVY in potatoes and the potential to impact other important agricultural crops, our state-of-the-art dynamic bioeconomic model is likely to have wide appeal. As such, we will parlay any initial grant funding into additional grant opportunities.

Both national and region-specific funds will be sought. According to Dr. Gray regional projects are particularly important as "a uniformly applied prevention or control policy may not be effective...the genetic diversity of PVY seems to differ among geographic areas." Region-specific projects will allow the team to customize the model to account for location-specific virus, vector, weather, and management features while national grants will allow for the team and collaborators to create breadth and possibly investigate multiple locations simultaneously. Funding to conduct such research will be sought though application for USDA-ARS potato-specific cooperative agreements, Western Sustainable Research and Education (WSARE) grants, and CSRESS-Special Grants Program for Potato Research.

TIMELINE

Project Completion Timeline by Objective and Personnel												
	April	May	June	July	Aug.	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Obj. 1 (Bond/Keeling Bond/GRA)												
Obj. 2 (Manter/Crowder/GRA)												
Obj. 3 (Bond/Keeling Bond/GRA)												

TOTAL BUDGET: $25,228

Personnel	
PI Salary and Fringe (1 month)	9,601
Grad Research Associate (1/4 time)	4,627
Subtotal	$14,228
Materials and Supplies	
ARS Lab Analysis (6 fields) and Supplies	9,500
Outreach Materials and Printing	500
Subtotal	$10,000
Travel	
Crowder/Manter	500
Bond/Keeling Bond/GRA	500
Subtotal	$1000
TOTAL	$25,228

REFERENCES:

Agro Engineering, Inc. November, 2007 http://www.agro.com/CropInfo/Potatoes/Diseases/pvxpvy.html.

Davidson, R., K. Sather, and R. Haslar. 2007. Presentation to the 2007 South Rocky Mountain Agricultural Conference.

Ehrlich, Jim. Executive Director of Colorado Potato Administrative Committee. Personal Communication. (11/07).

Heikkila, J. and J. Peltola. 2004. Analysis of the Colorado Potato Beetle Protection System in Finland. *Agricultural Economics* 31:343-352.

Marsh, T.L., R.G. Juffaker, and G.E. Long. 2000. Optimal Control of Vector-Virus-Plant Interactions: The Case of Potato Leafroll Virus Net Necrosis. *American Journal of Agricultural Economics* 82(3):556-569.

Pons, Luis. 2007. A Tale of Two Threats; Nematod, PVY re-emerge. *Spudman* Nov/Dec(2007): 18-19.