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Choosing the battles: The economics of area wide pest management for Queensland fruit fly

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ABSTRACT

"*Surely the best way to meet the enemy is head on in the field and not wait till they plunder our very homes*" *Oliver Goldsmith (1730–1774).*

Area-wide management (AWM) of crop pests is an alternative strategy for pest control to reliance on the uncoordinated control decisions of farmers. Relative to uncoordinated pest control, AWM has been shown to be cost-effective and, by reducing pesticide use, environmentally beneficial. The fact that AWM schemes provide imperfect public goods and are prone to free-riding means that most successful schemes depend on government funding, regulation, coordination and management. The economics of AWM concerns the economics of information and time in complex bioeconomic settings. This paper explores the economics of AWM in relation to Queensland fruit fly (Qfly), *Bactrocera tryoni* (Frogatt), a damaging pest and a major barrier to Australian trade in horticultural produce. We analyse the economics of roadblocks, surveillance and eradication. The results show that returns from tighter roadblocks are greater than returns from increased surveillance and enhanced eradication capacity. These results depend on market access rules, the spatial extent of the pest free area, the horticultural commodities at risk, and pest ecology.

Introduction

The growth of world trade and increased movement of people and goods has raised the risks to agriculture and natural environments from invasive organisms (Lichtenberg and Lynch, 2006; Mumford, 2002). Further, food safety standards have low tolerances for pesticide residues in food and markets requiring low pesticide and low pest risks are increasing (Hendrichs et al., 2005; Mumford, 2005). To export, Australian producers have to adopt pest management methods that satisfy increasingly stringent food safety and pest-free requirements. One alternative to intensive pre-harvest spraying and post-harvest treatments is the establishment of an area-wide management (AWM) scheme, where controls apply over a region (Devorshak, 2007; Faust, 2008). AWM has the potential to contribute towards increased food safety and reduce the environmental effects of pesticide use. With reference to Queensland fruit fly (Qfly) management in Australia, this paper explores what constitutes an economically efficient AWM scheme.

There are numerous studies of the scientific principles underpinning AWM.[1] However, detailed theoretical and empirical economic analyses of AWM design are rare. Exceptions include Mumford (2000, 2005), Enkerlin (2005), and Mau et al. (2007). Without economic analysis, it is difficult to assess the value of different management strategies, technologies and scale of operations of an AWM program. Furthermore, government departments managing AWM schemes are expected to be cost efficient and demonstrate that the benefits of AWM exceed the costs (Mumford, 2005).

Queensland fruit fly (Qfly), *Bactrocera tryoni* (Frogatt), is economically the most significant horticultural pest in Australia (Clarke et al., 2011; Dominiak et al., 2000; Gilchrist et al., 2006; Sutherst et al., 2000).[2] In regions where Qfly is endemic,

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[1] See for instance Koul et al. (2008), Tan (2000), Vreysen et al. (2007), Hendrichs et al. (2005), Klassen (2005), Lloyd et al. (2010), Jessup et al. (2007), and papers from the joint FAO/IAEA international conferences on area-wide control of insect pests.

[2] Qfly has more than 200 hosts, including stone fruit, citrus and table grapes, among others (see http://www.pestfreearea.com.au for a complete host list). Table grapes have been previously classified as a marginal host, but the fruit can sustain the insect from larval to adult stage in the laboratory (Clarke et al., 2011). Even though larvae do not always develop to maturity in the field, Qfly outbreaks have been reported to cause significant damage to grape producing areas (Dominiak, 2011). Citrus tends to ripen during winter periods when fruit fly activity is low, and thus experience a lower rate of infestation in general. Stone fruit are a preferred host.

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horticultural producers are either excluded from or have restricted access to export and domestic markets, and their profitability is reduced by pest control costs, yield reduction and post-harvest disinfestation costs (Lloyd et al., 2010).[3] Qfly is viewed by Australia's trading partners as a serious biosecurity threat to their horticultural industries. To reduce the risk of Qfly outbreaks strict import regulations are placed on Australian produce, for instance, requiring exported fruit and vegetables to be below a *Probit 9* likelihood of infestation.[4]

This paper presents an economic analysis of the design of AWM schemes for Qfly in Australia. The next section reviews the economic literature. Section "Biological and environmental characteristics of Queensland fruit fly" outlines aspects of Qfly biology relevant for an economic analysis of AWM design. Section "Key elements for the economic analysis of area-wide management for Queensland fruit fly" introduces the empirical bioeconomic model. Section "Case study for the Fruit Fly Exclusion Zone (FFEZ)" presents a case study of the Fruit Fly Exclusion Zone (FFEZ). Section "Results" gives results for optimal surveillance, roadblock activities and eradication effort. Section "Conclusion" concludes.

Background

AWM of Qfly is a form of public good (Burnett, 2006; Hennessy, 2008; Hinchy and Fisher, 1991). The principle behind AWM is that economies of scale, and a degree of non-rivalry and non-exclusivity in benefits means that

> "pests can be effectively managed using an organised and coordinated attack on their population over large areas rather than by using a field-by-field approach" (Koul et al., 2008, p.1).

Indeed, the uncoordinated effort of individual producers is generally insufficient for the effective management of mobile pests (Klassen, 2005; Perrings et al., 2002). Such schemes are typically not incentive compatible and are undermined by free riding and sub-optimal pest control by producers. Further, technologies and actions available to government, namely roadblocks, surveillance grids and sterile insect technology (SIT), would either be illegal for a producer group (due to land access issues) or would be infeasible due to the range of scientific expertise required. Therefore AWM schemes are provided by government, although producer groups are often required to share the costs.

AWM of fruit flies commonly involves monitoring of traps over large areas (surveillance), the control of movements of host produce (roadblocks), and the use of the sterile insect technique for the eradication of outbreaks. Investments in surveillance may reduce the time to detection of the pest population and investments in eradication capacity may reduce the time to eradication of a detected population (Fig. 1). Early detection means the population at detection is smaller and eradicated more rapidly.

In Australia, five market access rules apply to AWM of fruit flies:

(1) *Biosecurity rule*: in the absence of fruit flies, exported produce must be below the required Probit 9.
(2) *Capture rule*: corresponds to the spatiotemporal rules for the declaration of an outbreak, that is, the threshold number of fruit flies captured within a period and distance to each other that leads to outbreak declaration. Since the size of the infestation is not known with certainty it is assumed that under this threshold the risk of infestation is low.[5]
(3) *Area rule*: the area that loses area-freedom status for trade purposes when an outbreak is declared, called the suspension zone. This area has a radius between 15 km and 80 km from the outbreak origin. Produce grown in the suspension zone has to undergo post-harvest treatments before export to fruit fly free markets during eradication and for a period after eradication activities cease. The size of the suspension zone is established according to the intended market and the distance between consecutively trapped flies.
(4) *Treatment rule*: an outbreak zone is delimited around sites where the flies are captured. Eradication activities are carried out within the outbreak zone.
(5) *Recertification rule*: After eradication activities cease, access to restricted markets can only be restored after a period has elapsed during which no more flies are captured. The time to area freedom recertification in the suspension zone is prolonged until the risk of spread and establishment of a second generation is very low (see Fig. 1). This time is defined by the generational time span of Qfly, which is temperature dependant.[6]

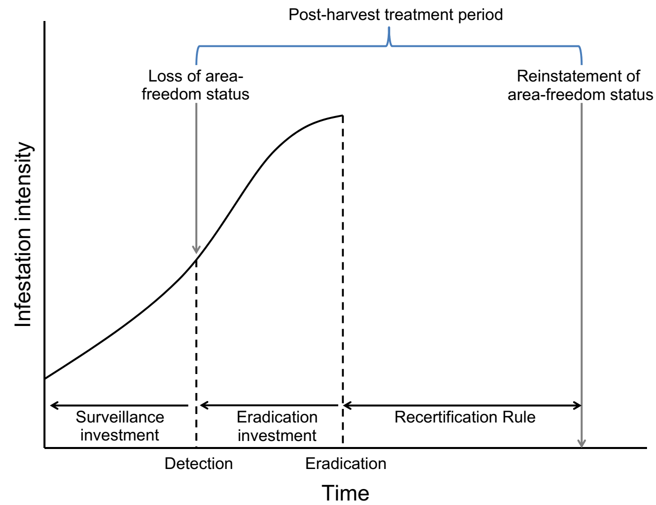

Fig. 1. Detection, eradication and reinstatement of area-freedom status, after Kompas and Che (2009).

The regulator's problem is one of designing the AWM program so that resources are allocated efficiently across surveillance, roadblocks and eradication. In implementing AWM programs the regulator faces the "weaker link" problem (Burnett, 2006), whereby sub-optimal prevention and/or control in a part of the AWM system lowers the returns to AWM. For instance, if one inspection roadblock is not effective in detecting infested fruit, the fact that all other roadblocks are effective is irrelevant. Burnett (2006) demonstrated that the incentive structure resulting from the weaker link public good problem causes contributors to under invest in pest management, emphasising the importance of the careful design of AWM schemes.

To date the only assessments of AWM schemes for Qfly in Australia have been aggregated benefit-cost analyses (BCAs). Such

[3] Qfly damages horticultural produce when females sting host fruit or vegetables to lay their eggs below the skin of the fruit. Larvae feed within the fruit, reducing its quality and rendering it unmarketable. It is estimated that without control, an infestation of Qfly can damage between 80% and 100% of host fruit and vegetable grown in the infested area (Sutherst et al., 2000).

[4] Probit 9 corresponds to 3.2×10^{-5} survival rate after treatment.

[5] The size of an infestation is determined by the number of flies present and the extent of the area they occupy.

[6] For a summary of restrictions regarding fruit fly outbreaks per importing country, see Appendix A in Florec et al. (2010a). Updates can be found per country in PHYTO (AQIS, 2008), Australian Quarantine and Inspection Service's plant and plant product export conditions database (available on http://www.aqis.gov.au/phyto/asp/ex_home.asp).