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Re-examining economic options for import risk assessments

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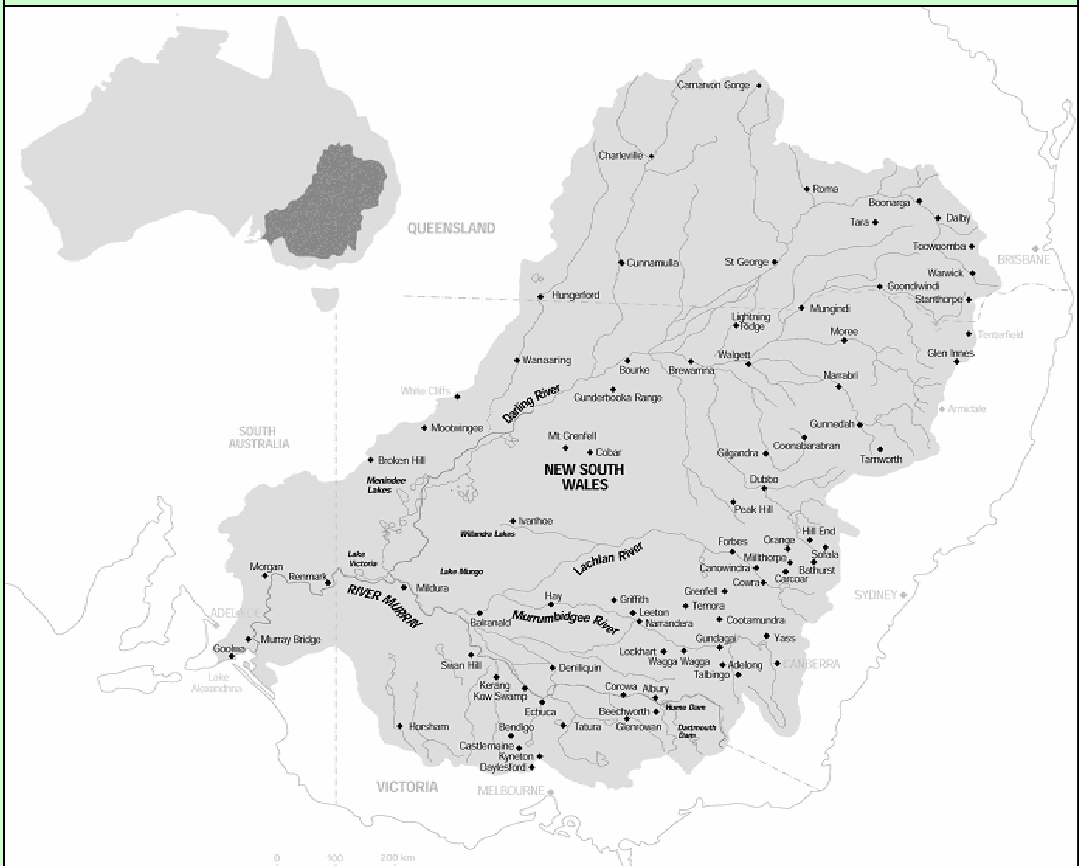

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Re-examining economic options for import risk assessments

By David Adamson[1] & David Cook[2]

Abstract:
The economic impacts of altering quarantine policies are divided into two main areas: trade evaluations, utilising a partial equilibrium approach to determine the benefits of market liberalisation; or pest management economics, used to determine the on-ground impacts of introduced species. This paper rationalises why these approaches need to be brought together within the policy framework of import risk assessments to provide a greater understanding of the benefits and risks from market liberalisation.

Key words: Biosecurity, pest management, import risk analysis, uncertainty

Introduction

Species are continually adapting and seeking to gain a comparative advantage when the opportunity presents itself. International trade provides another opportunity for exotic species to move to new areas[3] which may be free from their natural predators and if the environmental and social[4] conditions are favourable, they can flourish. The geographical isolation of Australia and New Zealand has allowed the evolution of unique environmental conditions, in the absence of numerous exotic species. If an exotic species successfully invades it not only impacts on the natural environment but on agricultural production systems, human health and potentially society as a whole.

To prevent global environmental homogenisation and keep domestic production systems free of exotic pests, quarantine barriers to trade have been established. Proponents of trade liberalisation mention two principal economic benefits: production efficiency as it enables market signals to reach producers who will reallocate resources; and consumers benefit from falling prices and increased choice. Quarantine restrictions to trade are often considered as non-tariff barriers to trade both by international exporters and domestic importers and are challenged. It is the role of import risk analysis (IRA) to examine existing quarantine barriers by determining the benefits and costs from removing quarantine barriers to trade and adjusting quarantine regulations accordingly.

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[2] CSIRO Entomology, Black Mountain, GPO Box 1700, Canberra ACT 2601, Australia , e-mail: David.C.Cook@csiro.au
[3] International trade can either speed up natural distribution or provide opportunities that would not have been possible without human intervention.
[4] Social in regards to identification and management before exotics can establish.

This paper will limit its discussion to Australia's IRA process and practices and the role of economics. To do this, we will firstly examine the policy environment in which economic analysis takes place; examine what approaches are used; talk about the role of risk and uncertainty; and suggest a framework to help decision makers balance the trade-offs.

The IRA process and policy environment

Internationally governments have established risk mitigation strategies in an attempt to curtail the damage caused by trade-related introductions of invasive species, which globally are estimated to be around US$1.5 trillion per annum (Pimentel et al. 2002). Aggregate regional and worldwide damage assessments of pest invasions are available, however specific studies on individual invasive species are limited and the examples generally determine economic loss as production impacts (Cook 2005). These unintended consequences of trade examples are insufficient to help provide judgments about the net economic impacts of the decision to remove quarantine barriers. Examples concerning the removal of quarantine barriers to determine the benefits to consumers (James and Anderson 1998) fail to explore the real costs of invasions.

Australia, like most World Trade Organisation (WTO) members, typically excludes the benefits of trade in favour of either quantitative or qualitative assessments of the impacts of possible invasive species when undertaking IRAs. Currently the factors considered relevant for justification of trade-restricting SPS measures are limited to potential production impacts resulting from invasive species introductions as a result of trade (see GATT (1994), Article 5, Paragraph 3). This is defined by Biosecurity Australia…

> "3.6
> In keeping with the scope of the Quarantine Act 1908 … and Australia's obligations as a member of the WTO, economic considerations are taken into account only in relation to matters arising from the potential direct and indirect impact of pests and diseases that could enter, establish or spread in Australia as a result of importation.
>
> The potential competitive economic impact of prospective imports on domestic industries is not within the scope of IRAs" (Biosecurity Australia 2003).

So for applications to gain access to Australian food markets, most of the effort is placed in detailed and scientifically rigorous IRAs carried out by Biosecurity Australia in consultation with other relevant stakeholders. These assessments ascertain whether or not trade in the commodity concerned exposes Australian industries and the environment to an unacceptably high level of risk. This risk is displayed as a qualitative matrix, as illustrated in Table 1, where the decision to exclude is represented by the shaded cells.

Table 1 Risk Assessment Framework

Likelihood of Entry and Exposure		Consequences: Negligible	Very Low	Low	Moderate	High	Extreme
	High	Negligible Risk	Very Low Risk	**Low Risk**	**Moderate Risk**	**High Risk**	**Extreme Risk**
	Moderate	Negligible Risk	Very Low Risk	**Low Risk**	**Moderate Risk**	**High Risk**	**Extreme Risk**
	Low	Negligible Risk	Negligible Risk	Very Low Risk	**Low Risk**	**Moderate Risk**	**High Risk**
	Very Low	Negligible Risk	Negligible Risk	Negligible Risk	Very Low Risk	**Low Risk**	**Moderate Risk**
	Extremely Low	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk	Very Low Risk	**Low Risk**
	Negligible	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk	Negligible Risk	Very Low Risk

The risk of exposure and consequences is the Appropriate Level of Protection (ALOP) and notionally represents the maximum level of risk deemed tolerable by regulators. In practice, this standard has proven to be illusive and, to date, no individual country has elicited its ALOP quantitatively (Henson 2001). From a political and decision making point of view this is highly rational as:

- How do you define, to society, what level of crop and livestock loss, or perhaps even loss of human life, the government considers "acceptable";
- Once defined it may open governments to attack from other WTO members if there are any inconsistencies in the application of the standard;
- We are talking about potentially irreversible impacts that may occur somewhere in time and space that could have detrimental impacts to one or more groups in society and decisions have to be made on incomplete data; and
- Risk and uncertainty in the future and the data underpinning the decisions may be flawed or subject to change from either the species evolving and/or climatic conditions altering so what was not a potential problem may become one.

This is why the ALOPs are stated semi-quantitatively and are described using generic, non-scientific language such as 'high', 'moderate' or 'low'. Changes to quarantine policy are not irreversible and once new or better information is available or conditions change in the exporting country, trade can be halted either temporary or permanently. For example the outbreak of foot and mouth in England lead to a temporary halt in live horses (shuttle stallions) coming to Australia in 2001[5]. While at the same time just because a country has gained access it does not mean it will engage in trade as Gascoine (2000) points out there is no Canadian salmon in Australia.

[5] Source accessed 06/02/07 http://www.daffa.gov.au/about/media-centre/aqis-releases/2001/uk_horse_imports_temporarily_suspended_due_to_foot_and_mouth

Decision makers have to weigh up the trade-offs in economic, social and environmental consequences of changes to quarantine policy when an IRA is undertaken. The potential benefits from market liberalisation with decreased prices for consumers and producer efficiency gains attributed to receiving clearer market signals have to be tempered with the risks associated with a potential introduction of exotic species which could impact on multiple agricultural commodities, cause irreversible environmental loss and pose human health risks.

One of the major problems associated with IRA is time, and Table 2 illustrates the start date of some on-going decisions. This delay can be perceived as a continuing barrier to trade and to mitigate this concern from 2007 all basic IRAs will take 24 months and extended IRAs 30 months[6]. Although at the same time, it was announced that increased effort will be placed into their communication strategy. This policy announcement effectively negates all the work that Leroux and MacLaren (2006) did on investigating optimal time to remove quarantine barriers based on information available.

Table 2 Start dates of on-going IRAs in Australia

Commodity	**Application**	**IRA Start Date**
Bananas	Philippines	28 June 2000
Apples	NZ	25 Feb 1999
Prawns	Domestic Challenge to Process	1998
Table Grapes	Chilli (95) USA	11 Dec 97
Chicken Meat	USA (89), Thailand (98), Denmark (90)	10 Dec 1998
# Based on Biosecurity Australia web site: http://www.daffa.gov.au/ba		

In 1996 the Narin review into Australian quarantine recommend that a centre concentrating on quarantine risk analysis (recommendation 47) was needed to provide transparent and consistent (recommendation 34) evaluations that identify potential industry adjustments costs (recommendation 41). The Australian Centre of Excellence for Risk Analysis was established in 2006 and currently they do not employ an economist.

Consequently standardised approaches to economic evaluations of impacts have not been developed and economic reviews are generally undertaken as consultancies, financed by either Biosecurity Australia or industry groups, and the raw data and assumptions underpinning these reports and spreadsheets are generally not available for review or discussion. The economic arguments presented to decision makers in general take on two forms: partial equilibrium analysis to determine if consumers would be better off importing the item; and economic arguments describing what could occur to one production system if the trade liberalisation introduced some exotic species and occasionally the consequences for domestic production is discussed.

[6] http://www.daffa.gov.au/about/publications/import-risk-analysis-review accessed 12/01/07

Without a consistent and transparent economic approach discussion papers like Margolis and Shogren (2004) suggest that countries can use quarantine barriers to mitigate trade and provide hidden welfare payments to producers. Countering this argument is gains further complexity when attempting to place dollar values on native fauna and flora. While in many cases, determining the potential impact on native species is difficult as there may have been no interspecies interaction before and the natural comparative advantage between the two species is at best an expert opinion. This leads us to how economics is used is IRAs and identifying what may be missing in current evaluations.

Economic Approaches to IRA

The import risk analysis of trade liberalisation for a specific commodity from specific sources requires complex scientific information detailing, for example: lists of potential exotic species that may be distributed with changes in quarantine regulation; alternative theories regarding the invasion pathways; reviews of known production and environmental impacts; management options for adverse impacts; and comments regarding the likelihood of these events and contingencies for unforseen consequences. The economic reviews of such decisions only incorporate a fraction of the data that is collected.

The economic approach to IRA in Australia owes its development to Hinchy and Fisher (1991) and it provides an excellent introduction to the complexities for economic analysis in this area. There has been little expansion in the methodological debate since. Yes there are practical examples using their suggested approaches but probably due to the policy constraints[7] economic analysis operates in, the debate into the all costs and benefits in an IRA has been restricted.

The benefits from trade liberalisation are lower prices for consumers and production efficiency as growers receive clearer market signals. However, by opening up trade corridors, these benefits have to be tempered with the low probability but potentially high negative economic and non-economic impacts from exotic species taking advantage of new distribution pathways. Practical economic examples have generally concentrated either on producer losses or consumer gains for a single industry by a single species and have generally avoided quantifying, in dollar terms, non-market (environmental) impacts or multiple commodity impacts. Consumer and producer welfare evaluations take the form of partial equilibrium analysis and or financial[8] impacts for industries both of which ignore the strengths of the other approaches to mitigate their own weaknesses.

Unfortunately little work has been undertaken in combining the two approaches and this paper will outline a couple of options and raise the necessity for the Government to develop a consistent methodology. Evans *et al* (2002) argue that economists and scientists will have to work closer and this is the basis of the pest management economics

[7] see page 2 concerning limitations on economic approaches
[8] Financial in terms of these examples rarely take into account operator labour and capital considerations.

i.e. integrated pest management (IPM). As Longworth and Rudd (1975) mention pest management economics is a neglected field compared to other issues in agricultural economics. Classical works in these areas are by Auld et al (1978/79), Auld et al (1987), Hone (1994) and they discuss techniques that have been adapted to pest management economics including: economic thresholds; pay-off matrices; resistance management; the spatial and temporal aspects of density and distribution; and discussions concerning the impact of climate change. All of these issues influence the economic, social and environmental trade-offs that should be considered when determining the net impact of trade liberalisation.

The two approaches differ to each other in regards that one is trying to determine if the change in consumer welfare is greater than the change to producer welfare and if so the decision should be to import. While the other is trying to establish what could the impact be on business profitability from an external shock from a biosecurity outbreak.

Partial and General Equilibrium

Partial equilibrium examines the changes in consumer and producer welfare and commonly only the impact on producers is considered. The work by James and Anderson (1998) and Cook and Fraser (2002) however, show that consumers have increased welfare under removal of quarantine barriers resulting from falling prices. This approach has been expanded to utilise a general equilibrium model (Monash model) by Dent (2002) looking at the impact of foot and mouth and later by Wittwer *et al* (2005) into plant diseases. Leroux and MacLaren (2006) use a partial equilibrium approach to determine the optimum time based on available information to change quarantine restrictions. All of these models have the same limitation in that they are looking at a single species entering and that is not the case when an IRA is undertaken.

It is possible to model multiple species risk and determine the impacts on regional economies to highlight spatial risks posed by alternative species. This becomes very important because IRAs in Australia do determine if some areas remain ‘free’ of exports and they can also determine what treatment/s commodities require to gain market access.

The following example applies to Chilean table grape imports and why Western Australia should be excluded from opening their markets to Chilean and domestic producers. This is based on Cook (in press). With greater market access into Australia, Chilean exports would concentrate on the eastern seaboard markets to minimize shipping costs. If this occurs then potentially domestic producers could aim to sell their product in Western Australia where market prices are higher. As Western Australian grape producers are geographically isolated they are free of not only the threats identified from Chile but several domestic pests common on the eastern seaboard: Queensland Fruit Fly; European Red Mite; and Grapevine Fanleaf Virus. So what are the benefits and costs to Western Australia from this decision?

Figure 1 Stylised partial equilibrium model

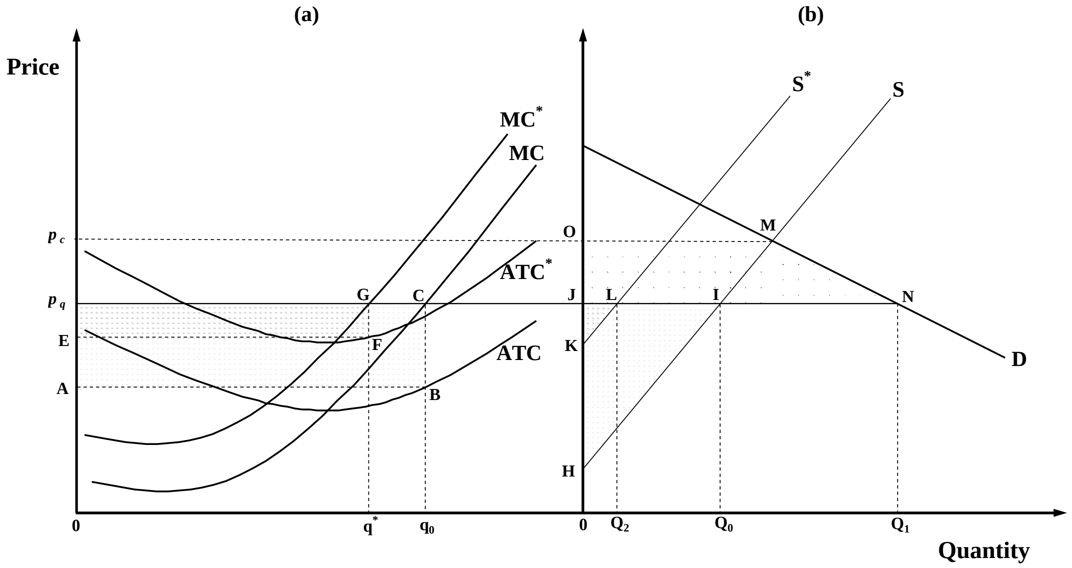


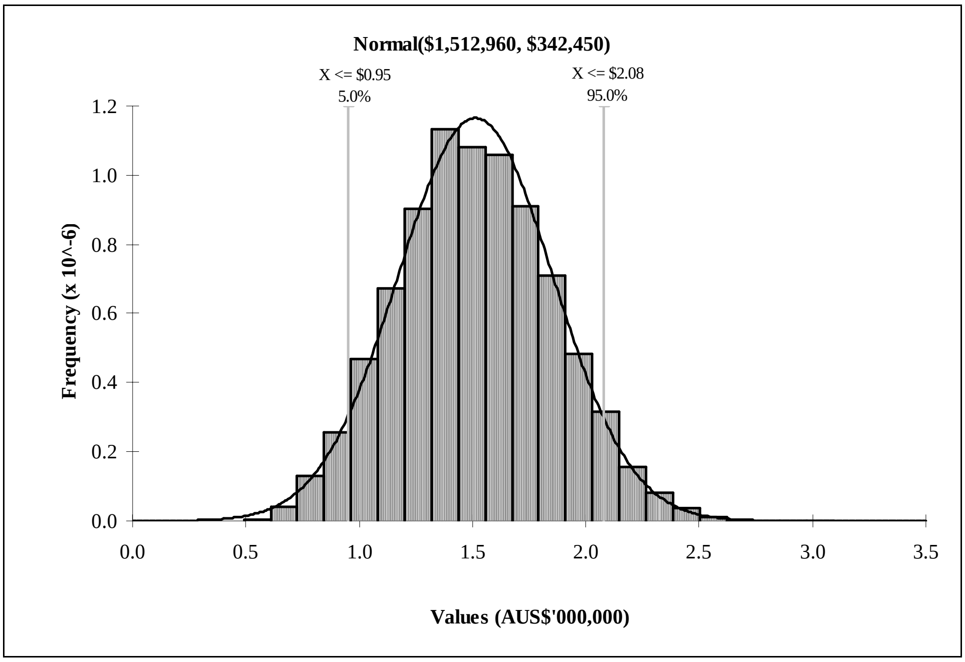
Figure 1 provides the partial equilibrium model of table grape importation into WA and subsequent invasive species introduction. Panel (a) depicts the production behavior of a WA table grape producer. Facing a domestic market price (p_q) a quantity (Q_0) is produced. Producer surplus is determined by the difference between the cost of producing the last unit of grapes (the marginal cost, MC) and the average total cost (ATC) of producing each unit up to that point (assuming, for ease of illustration, negligible variable costs of production). Total producer surplus is therefore given by the shaded area ($ABCp_q$) (Cook, in press).

If an invasive species now enters and becomes established in the production region, the additional management costs associated with its management will force the MC and ATC functions upwards to MC* and ATC* respectively, where production falls to q* and producer surplus falls to the heavily shaded area ($EFGp_q$). Summing this effect across the entire industry in panel (b), the effect of the invasive species is seen as a contraction of the supply curve from S to S*, and consequent reduction in total producer surplus from the lightly shaded area (HIJ) to the heavily shaded area (JKL) (Cook, in press).

This loss is offset by consumer gains. By opening the domestic market to imports the prevailing market price falls from (p_c) to (p_q). In response demand increases to (Q_1) (Q_0 of which is supplied by WA growers). Consumer surplus (the area below the price line and above the demand curve, D) therefore increases by the area (NMOJ). This surplus is unaffected by the invasive species incursion despite domestic market supply falling to Q_1.

From the increased competition the Western Australian consumers welfare would increase by around $1.5 million (see Figure2). Yet at the same time if the increased domestic trade did allow pests did move west then the cost to producers would be approximately $10 million (see Table3) from the movement of domestic pests.

Figure 2 Increase in Consumer welfare from liberalising the table grape market in WA



Source Cook (in press)

So the spatial aspects should be included in partial equilibrium analysis as well as understanding the current distribution and densities of domestic pests. Such an approach could help determine domestic exclusions zones if necessary and by integrating multiple incursions it provides a greater understanding of the issues facing an industry.

Table 3 Impact of Pests to Western Australia

Pests	5% Confidence Interval	Mean	95% Confidence Interval
Invertebrates			
Queensland Fruit Fly	$ 0	$ 1,066,980	$ 3,373,750
European Red Mite	$ 0	$ 668,350	$ 1,949,590
Pathogens			
Grapevine Fanleaf Virus	$ 0	$ 8,583,760	$ 17,436,140
TOTAL	**$ 0**	**$ 10,319,090**	**$ 22,759,480**

Source: Cook (2003)

Partial equilibrium analysis provides a lot of useful insights but there are issues such as wether the industry will survive post market liberalisation, which are important to understand as compensation or adjustment costs. The assumption of homogenous production and supply is one of the partial and global equilibriums weakness as discussed some producers do survive and in fact thrive post deregulation either due to management ability and/or due to natural comparative advantages from either their landscapes or production systems. This survival of external shocks to a production system can be examined under a farming systems approach.

Moreover, analyses like the partial equilibrium example above seldom mention the appropriate means of transferring revenue from those who gain as a result of importation to those who lose. Provided the gainers gain more than the losers lose, the losers can be compensated for their total loses while a net gain is still achieved. However, precisely how this exchange takes place in the case of agricultural industries is not clear. Curiously, special government grants and tax concessions tend to be used rather than the social security system.

Pest Management and Farming Systems

The economics of pest management aims to understand the impact a species has on the production system and the corresponding change to the entire farm system by choosing alternative responses to a species. By understanding the production system on a spatial scale the impact from external shocks can be modelled to determine robustness of the system. Unfortunately most IRA evaluations avoid this and the New Zealand request to export apples to Australia will be examined in this case. Hinchy and Low (1990) mention the need to evaluate the impact of a change in biosecurity protocols on farm return, although it was not followed up in the subsequent study by Bhati and Rees (1996).

Most analysis in this field determines the financial impact per hectare value of the impact of a species i.e. determines the costs on $/Ha basis, often from gross margin budgets and then multiple up to determine a regional impact. In this case the true economic impact is not determined because they leave out incorporating capital and operator labour.

Secondly studies of this nature generally consider that there will be significant increases in management expenditure and in reality this is not the case. For example with Siam weed, the forecasted increased management costs at light to medium densities of infestation for a citrus producer are negligible or relatively small in terms of total management costs as an infestation would be controlled by current practices. Citrus producers slash the area 11 times a season and apply herbicides to control existing weeds so Siam weed would struggle to encroach into a well managed system (Adamson, etal 2000). While as Miller and Scanlan (1997) point out producers in rangeland systems control about 10% of any infestation per year due to the issues of distribution and density. So the possibility of over inflating values is of concern.

In 2004-05[9] Australian agriculture on average made a loss of about $9,000, and annual pest management for that same period was around $18,500[10] per annum, which accounted

[9] Source Martin etal 2006
[10] ABS 2006

for approximately 8% of total farm costs. However any invasion, especially by a disease may increase management costs or decrease yields sufficiently enough to influence capital expenditure. Consider the potential impact of fire blight on an Australian farm and the decision to invest in an apple production system, as illustrated in Figure 3 & 4.

Figure 3 Increased Management Costs + 10% yield loss every 2 years (Excluding Capital)

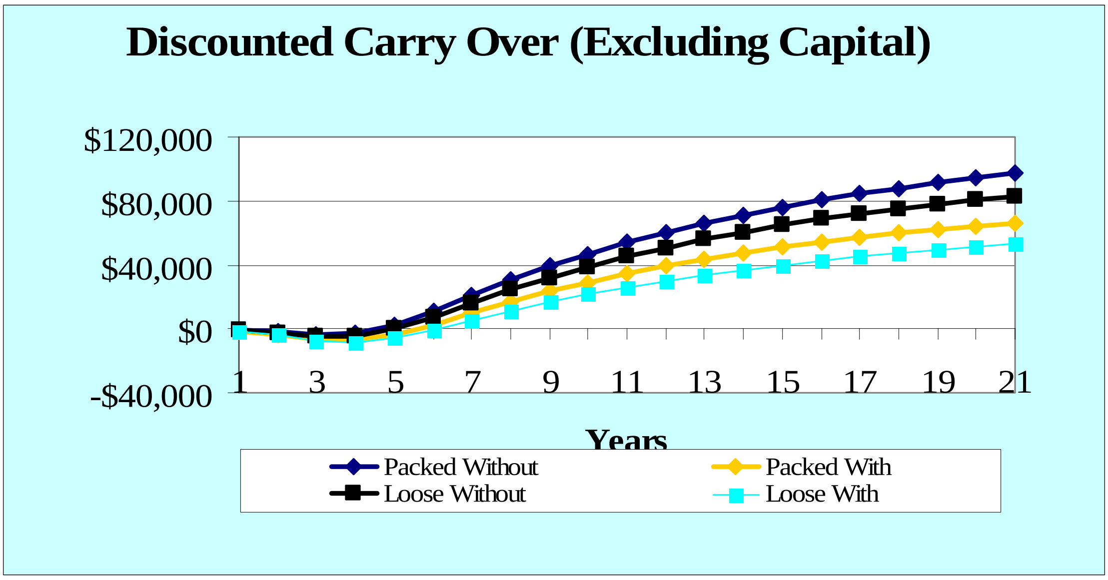
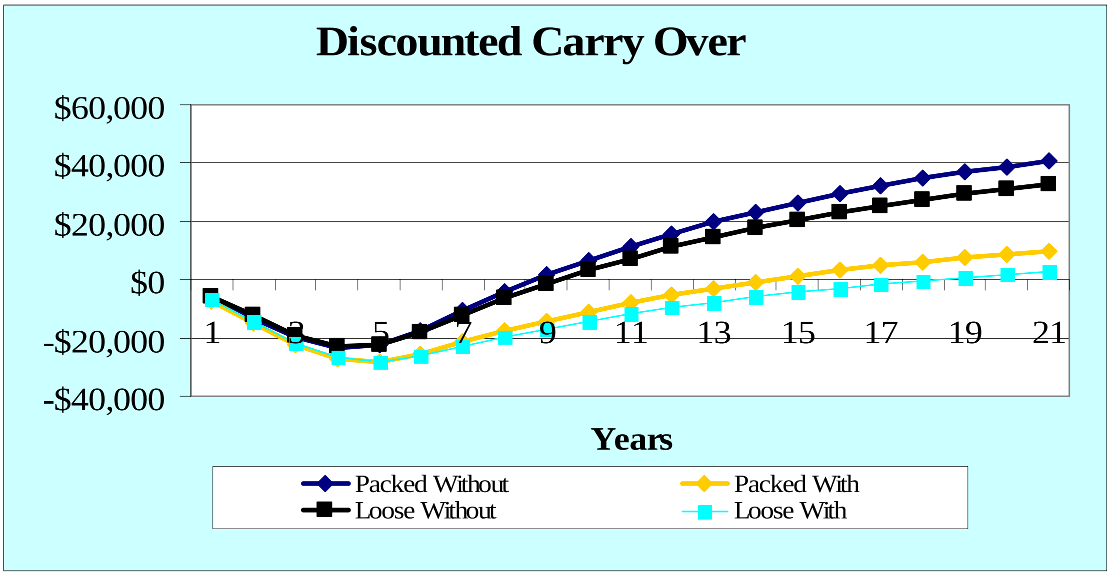


Figure 3 provides the changes in income and variable costs for two alternative apple production systems: packed apples; and loose (bulk bins) apples excluding capital. Figure 4 provides the same information taking capital into consideration. The ‘with’ and ‘without’ case here refers to fire blight. The information that is displayed shows the discounted carry over return from investing in apples with fire blight present in Australia, increased management costs and an outbreak of fire blight every two years.

If you do not consider the role capital and producer incomes plays in the evaluation, it is very easy to see that in Figure 3 that fire blight would have no impact to the industry. While in Figure 4 when you take these factors into consideration the breakeven point for the investment moves by 6 to 9 years for the packed and loose enterprises respectively. This analysis suggests that a farmer would be unwise to replant their orchard at the end of the 20 year production cycle as the risks posed by other events, for example, hail and storm damage, could easily turn the return of the investment into a net loss.

Figure 4 Increased Management Costs + 10% yield loss every 2 years (Including Capital)



Critical to the frequency of infestation in the above argument is the fact that the major management option used overseas (Streptomycin an antibiotic) is no longer approved[11] for use in the agricultural sector as it is a common antibiotic for controlling diseases in humans. Without this management option[12] the role of on farm hygiene and careful control of foliage growth (fertilizer regimes, growth retardants and pruning) will become critical for producers if fire blight is introduced into Australia again[13].

So what we can see here is if you understand the impact of an exotic may have on a production/farming system, you can then determine the potential impacts for an industry under trade liberalisation and inform the industry of issues to consider. For example, if prices fall producers know to either increase profitability by reducing costs or increasing production and/or adjust out of the industry or agriculture altogether.

Changing production systems is not easy and the physical and mental stress involved in such actions is considerable in the short run for long term economic gains. Harris (2005) points out that many industries remain competitive post removal of subsidies and/or quarantine protection but individuals in the short run do require financial help in adjustment. It is unfortunate that issues of adjustment are ignored in IRA as it does not provide the full picture. For example, Queensland growers affected by citrus canker could apply for a reimbursement of $80 per citrus plant and $20 for each citrus plant for the re-establishment of a citrus orchard[14]. Once again it is important to remember that biosecurity outbreaks commonly impact on multiple production systems in space and time and the social costs of compensation can be significant. With the current system the

[11] Streptomycin was used in the livestock industry until 1995.
[12] NZ has a biological control spray, Blossom Bless®, but is not registered for use in Australia.
[13] There was an outbreak of fire blight in the Melbourne botanic gardens in 2000 that was eradicated.
[14] http://www.qraa.qld.gov.au/productitem.jsp?product=382

government is basically acting as an insurance agent when adverse conditions arise. (**JQ source?)**

By fully understanding the production systems and the impact changes in quarantine barriers can have for consumer and producers, we gain a far better understanding of the issues facing producers and whether or not consumers are subsidising producers.

Environment and Health Impacts

Understanding the impact on the environment from the introduction of exotic species can be done in one of two ways. Firstly identifying the area involved and the native flora and fauna at risk provides a significant amount of information for decision makers to use. Attempting to place dollar values on these impacts is the role of non-market evaluation tools.

Attempting to quantify the impacts is important, however there is still a lot of debate on this issue in terms of the best way forward. There is a workshop preceding this conference on this issue which may make some headway, but there are still a lot of unanswered questions to these approaches. Mallawaarachchi (2000) provides a comprehensive investigation into economic and environmental trade-offs but as he argues when the science is week people rely on beliefs and value judgments which may distort the real costs.

The quantification of impacts in terms of areas (hectares) in a spatial form (national parks, difference biophysical regions) and lists of native species at risk in a basic five raking (minimal to extreme) system does provide a significant amount of information for decision makers.

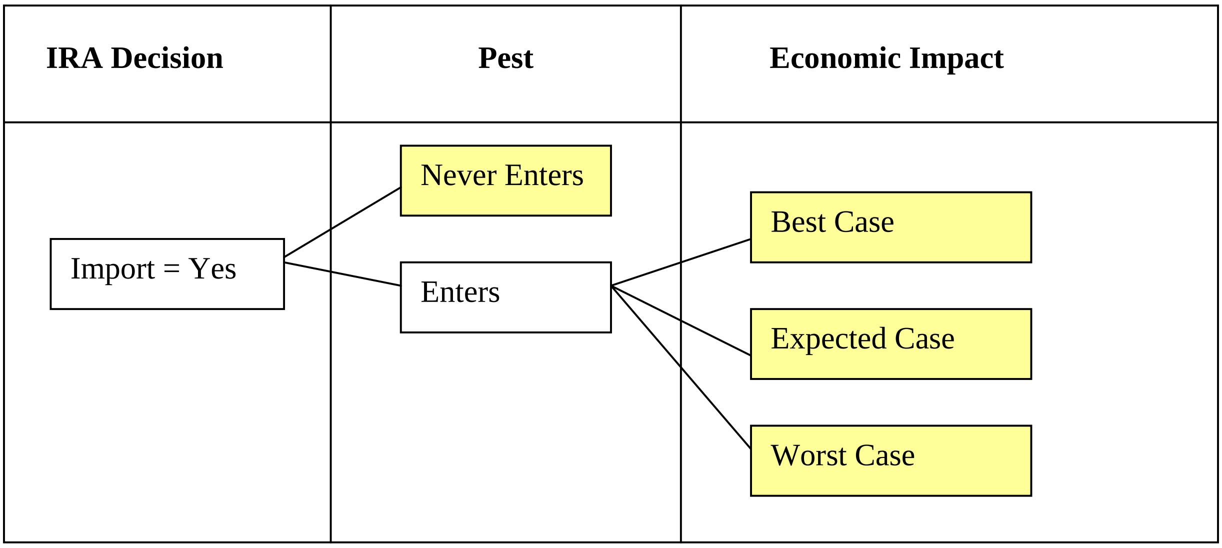
A State Contingent Approach to Risk and Uncertainty

Dealing with risk and uncertainty is at the core of IRA. As Hinchy and Fisher (1991) point out, the probability of an event multiplied by the probability of a second event times by the probability of a third event leads to a very small number indeed. As IRAs have to be communicated to a large stakeholder group the target audience can easily get lost in the discussion of how risk and uncertainty is dealt with in Monte Carlo evaluations, Bayesian probabilities, etc. Hinchy and Fisher spent significant time discussing the issue of how risk and uncertainty best be explained and detailed.

A state contingent approach to risk and uncertainty can be adapted easily into current practices and provides a quick way of communicating the economic trade-offs and identifying where the areas of 'unknowns' exists. See Chambers and Quiggin (2000) and Quiggin (2005.a) for a full description of the approach to production under uncertainty. The identification of 'states of nature' is exactly the same as the work by Norton (1985 & 1994) where the use of decision trees is described as the optimal way to highlight and communicate the ‘technically possible’ versus the ‘practically feasible’ decisions available for pest control, or in this case exotic incursion management.

By identifying management responses to alternative scenarios of pest incursions scenarios it allows for the information to be displayed in a generalised pay-off matrix to account for alternative pest pressure and distribution through time. By expanding this process to include a state contingent analysis approach to risk and uncertainty, i.e. for every state of nature there is a know probability, in this case invasion scenario, we provide an effective way to display complex issues showing the trade-offs, risks and uncertainties of the decision to allow greater market access. Figure 6 provides four states of nature from an IRA decision to allow greater market access: one where the pest never enters and three economic impacts from a biosecurity outbreak.

Figure 5 IRA Decision Tree and the Potential Pest Impacts



By defining each state of nature you avoid loosing the best and worst cases in the noise of an evaluation and you move away from a stochastic to a non-stochastic model which allows you to negate uncertainty. By stipulating all concerns of the relent stakeholders as a state of nature you end up with a framework that is easy to explain, especially to non-economists which should fit into the policy communication requirements mentioned in section 1.

Bringing Everything Together

Hinchy and Fisher (1991) and Binder (2002) agree that cost benefit analysis provides a solid framework for comparing the costs and benefits of policy decisions. By incorporating the best bits of all approaches within a state contingent framework you are able to show how consumers could benefit from decreased prices, illustrate alternative scenarios of pest incursions and management responses and discuss the impacts on the environment. The decision tree (Figure 6) provides the possible states of nature by allowing the importation of a commodity from a previously banned exporter. Here there are two potential paths a pest can have: either it enters or it does not. If it does enter then there are three potential impacts that pest may have. The 'Never Enters', 'Best Case', 'Expected Case' and 'Worst Case' provide us with four states of nature.

Table 4 then provides the potential pay off matrix for IRA decision and for this example it has been assumed that the net economic benefit of allowing trade in is $100 and then for each state of pest pressure (low, medium and high) a proportion of the potential net benefits of trade are lost. The potential losses should then be able to incorporate the range of viewpoints from the benign to extreme in terms of pest impacts on domestic production and in this case 10 states of nature have been defined: one state where the pest never enters and nine states where the pest enters and causes some level of impact on the potential benefits of market liberalisation.

Table 4 IRA Pay off Matrix

Biosecurity Outbreak	**Pest attack (State of Nature)**		
	Low	**Medium**	**High**
Never Enters	**$100**		
Enters, Best Case	$100	$50	$30
Enters, Expected Case	$20	-$50	-$80
Enters, Worst Case	$0	-$100	-$200

Table 5 provides an example of how to apply a state contingent approach for an import risk assessment on an annual basis. For each state of nature regarding an IRA decision we can determine the economic value and assign a probability of this event occurring. In this case the IRA decision would be to allow trade in this commodity from the given country as the net benefit to the importing country is positive ($3.30).

Table 5 IRA Pay off Matrix for year x

Biosecurity Outbreak	**Pest attack (State of Nature)**		
	Low	**Medium**	**High**
Never Enters	40.00%		
Enters, Best Case	2.00%	5.00%	1.00%
Enters, Expected Case	5.00%	15.00%	5.00%
Enters, Worst Case	5.00%	13.00%	9.00%
Sum or Probabilities	100%		
		$3.30	

Table 6 State contingent analysis: Multi-period Benefit

Year	No Entry	Enters, Best Case Pest impact			Enters, Expected Case Pest impact			Enters, Worst Case Pest impact			Benefit of Trade	Discount Rate (10%)	Discounted Benefits
		Low	Medium	High	Low	Medium	High	Low	Medium	High			
1	$20	$20	$20	$20	$20	$20	$10	$20	$0	-$12	$14	0.91	$13
2	$40	$40	$40	$40	$40	$20	$15	$20	-$50	-$50	$15	0.83	$12
3	$60	$60	$60	$60	$60	$20	$10	$0	-$100	-$40	$19	0.75	$14
4	$80	$80	$80	$80	$60	$0	$0	$0	-$120	-$150	$12	0.68	$8
5	$100	$100	$80	$80	$50	$0	$0	$0	-$80	-$120	$28	0.62	$17
6	$100	$100	$80	$60	$40	-$5	-$20	$0	-$100	-$150	$20	0.56	$11
7	$100	$100	$80	$50	$30	-$20	-$40	$0	-$100	-$170	$15	0.51	$8
8	$100	$100	$60	$30	$20	-$50	-$60	$0	-$80	-$250	$3	0.47	$1
9	$100	$100	$50	$30	$20	-$50	-$80	$0	-$120	-$200	$1	0.42	$0
10	$100	$100	$50	$30	$20	-$50	-$80	$0	-$100	-$200	$3	0.39	$1
										TOTAL	**$130**		**$87**

Table 6 shows how we can expand the basic example by introducing time and implement the whole process within a cost-benefit frame work. This then allows us to deal with assumptions such as alternative distributions, climate change scenarios, density/damage functions, multiple or single commodities impacts, etc through time and space.

The obvious difficulties in such a system are the determination of the probability (weighting) of each state of nature. Although in such a system the subjectivity of the weightings is visible and justification of each position must be made explicit by the decision maker. Using either expert surveys and/or utilising focus groups to reach a consensus does provide one mechanism to limit subjectivity. Then by providing the individuals involved in such a process or external reviews with a copy of the model to play with at their leisure you minimise their residency in accepting the decision. Alternatively as Quiggin (2005.b) suggests by utilising the notion of the precautionary principle greater weighting can be applied to the worst case scenarios to compensate for uncertainty.

The process is not about hiding the risks and uncertainty it is about expressing them openly for discussion. The more the risks, uncertainties and assumptions are discussed, challenged and tested the more likely that the results will be accepted by the larger audience. Modelling and using a state contingent approach can provide a platform to visualise and communicate the variables of concern.

Communication and Modelling

As Nunn (2001) points out, communication is vital in getting the message across in a multidiscipline environment. IRAs involve a complex and diverse set of interest groups, so there is an underlying question that gets ignored: how do I best present the information so that the bulk of the participants can understand what I have done. So a question exists, should we compromise the work and move back from the cutting edge of R&D or just make sure that we get the definable right?

As mentioned Australia does not have a published/or accessible standardised model that allows for even a back of an envelope study. Reports like Hinchy and Low (1990) and Bhati and Rees (1996) do not specify the regional data used and in some cases how the economic pest impact was determined.

If such a model/platform were to be developed it should be widely available for investigation. The model would have to be user-friendly and be able to be used to gather as well as disseminate information in an easily digestible format.

Summary

IRAs are complex procedures that now face time limits on their development. They are highly contentious for industries threatened by quarantine deregulation but there can be significant consumer benefits that are often ignored in the processes. The weighing up of the trade-offs is helped by adopting a state contingent framework to highlight the areas of unknowns and in order to make the process transparent a consistent method needs to be adopted. The failure to examine as many benefits and costs from changing quarantine protocols means that the Government is willing to forgo either economic efficiency by adopting a precautionary principal in terms of liberalisation or is acting as an insurance agent for producers, the environment and social costs when adverse events occur.

By not having a quantitative economic framework to investigate the issues, even for domestic use only, questions could be raised by international exporters and domestic importers trying to access domestic markets. For example, how have consumer benefits, 'risk' of 'entry & exposure' and 'consequences' been determined. The use of qualitative weighting is subjective and has been challenged in the recent senate review into the apple IRA decision:

> Recommendation 2
> 3.47 The Committee recommends that Biosecurity Australia review the weighting given to the economic consequences in its risk modelling[15].

[15] Senate Rural and Regional Affairs and Transport Legislation Committee, (2005)

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