Benefit-Cost Analysis of Area Wide Management (AWM) of Fruit Flies in the Central Burnett District of Queensland

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Executive Summary

The Central Burnett district is the major citrus production area in Queensland and contributes about 80 per cent of Queensland production. The Queensland fruit-fly (*Bactrocera tryoni*) which is the most widespread and damaging of the Australian species is also endemic to the Central Burnett area.

Queensland fruit fly is the most significant quarantine market access barrier for Central Burnett citrus. The Central Burnett Area Wide Management (AWM) project has aimed to address this issue by providing a systems based alternative to fruit fly control, which is hoped will be able to underpin quarantine assurances for Central Burnett fruit.

Fruit export protocol for South Australia (SA), Western Australia (WA), and Tasmanian interstate markets require that all fruit undergo post-harvest chemical treatment with dimethoate. Queensland citrus exports to these markets are worth approximately $15 million per year.

The Interstate Certification Assurance (ICA)-28 is an assurance scheme accepted in Victoria that enables producers to take a systems approach to fruit fly control and remove the need for post harvest use of dimethoate. The AWM project will underpin negotiations to extend the ICA-28 to include SA, WA and Tasmania. The Australian Pesticides and Veterinary Medicines Authority (APVMA) is currently reviewing the acute daily reference dose of dimethoate on fruit, which may lead to the decision to ban the use of the chemical. This will cause loss of market access to SA, WA and Tasmania.

This study is a benefit-cost analysis on the AWM project, focussing on the benefits to Central Burnett producers. The benefits are found using the state contingency approach, considering the probabilities of the outcomes of both the ICA and the APVMA decisions, with and without AWM.

This study has found that the AWM program has the potential to dramatically reduce the negative impact of the removal of dimethoate on the citrus industry. Without AWM the removal of dimethoate by the APVMA would cost the Central Burnett citrus industry around $4.5 million due to the loss of access to domestic markets. With AWM the probability of a worst case scenario decreases and the same decision on dimethoate would cause losses of $2.4 million. Although the AWM project will not prevent the removal of dimethoate, it will reduce the negative impact on the industry by $2.1 million per year.

At a discount rate of 5 percent, the NPV of the AWM project over 10 years was found to be $5.2 million, with a BCR of 2.27:1. These results indicate that the project is of net benefit to Central Burnett producers and the investment costs can be justified.

The AWM program in the Central Burnett provides benefits to all horticultural commodities affected by fruit fly. However through this study it has been shown that the program is cost efficient even when only benefits to citrus producers are included. It can therefore be assumed that the overall value of this program would be higher than that calculated in this study.

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1. Introduction

The aim of this paper is to determine and quantify the potential benefits of AWM in the Central Burnett. The benefits of AWM will be found by modelling the Central Burnett citrus industry, using a "with and without" scenario, taking into account possible changes in Biosecurity trade policy viz. the decision to be made on dimethoate by the Australian Pesticides and Veterinary Medicines Authority (APVMA) and the possible extension of the Interstate Certification Assurance (ICA) 28. The impact of these decisions on the Central Burnett citrus industry, with and without AWM, will be compared to find the overall program benefits of AWM.

1.1 Control

Integrated Pest Management (IPM) has been in practice for more than 20 years in the Central Burnett district, and regular protein baiting on most orchards has been employed as part of the program. Geographic factors, climatic conditions, and current on-farm fly controls result in very low fruit fly numbers across the entire Central Burnett district in the winter months during the citrus season.

The AWM project (HAL Project Number AH03002) trialled, for the first time, a coordinated approach to improving fruit fly control over an entire region through implementing baiting and Male Annihilation Technology (MAT) in all host crops (citrus, table grapes and mangoes) and in backyard fruit trees in the towns of Gayndah and Mundubbera. In MAT, wicks dosed with male lure and insecticide are placed throughout the orchard to attract and kill male flies on a year round basis.

1.2 Quarantine implications

Queensland fruit fly is the most significant quarantine market access barrier for Central Burnett citrus necessitating pre-harvest and post-harvest measures for both interstate and export trade. Access to South Australia (SA), Western Australia (WA), and Tasmanian interstate markets require that all fruits undergo post-harvest chemical treatment with dimethoate. Queensland citrus trade to these markets is worth approximately $15 million per year.

1.2.1 Interstate Certification Assurance Scheme (ICA-28)

The national Interstate Certification Assurance (ICA) Scheme was developed to provide an efficient and effective alternative to traditional inspection and certification of plant health by government inspectors.

ICA-28 is one such assurance that enables producers to take a systems approach to fruit fly control by substituting pre-harvest bait spraying and post harvest inspection for the post harvest use of dimethoate (Table 1.1). At present it is accepted only by the Victorian market. However, many growers still use dimethoate treatments to access Victoria, mainly because of the convenience of putting all fruits through the postharvest treatment line in centralised packing sheds thus enabling access to all interstate markets.

Table 1.1 Interstate Certification Assurances (ICA) requirements for dimethoate in Australian states

State	ICA	Explanation
Queensland	N/A	Q-Fly already exists
New South Wales	N/A	Q-Fly already exists
Northern Territory	N/A	Q-Fly already exists
Victoria	ICA-28	Pre-harvest baiting and post-harvest inspection
	ICA-01	Dipping with dimethoate
	ICA -02	Flood spraying with dimethoate
South Australia	ICA-01	Dipping with dimethoate
	ICA-02	Flood spraying with dimethoate
Western Australia	ICA-01	Dipping with dimethoate
	ICA-02	Flood spraying with dimethoate
Tasmania	ICA-01	Dipping with dimethoate
	ICA-02	Flood spraying with dimethoate

1.2.2 Australian Pesticides and Veterinary Medicines Authority (APVMA)

The Australian Pesticides and Veterinary Medicines Authority (APVMA) is the national independent regulator of pesticides and veterinary medicines and was created under the Department of Agriculture, Fisheries and Forestry (DAFF). This authority is currently reviewing dimethoate and fenthion because of toxicological, occupational health and safety, residue and trade concerns. A consequence of the review may be that the insecticide can no longer be used as a post-harvest treatment, without which, access of fruit to the SA, WA and Tasmanian markets may be denied.

In the case of citrus, the acceptable levels of residue will differ depending on the thickness of the peel in relation to the size of the fruit. Therefore there is still much uncertainty as to what fruit will be subjected to restrictions on dimethoate usage.

2. Description of the Central Burnett Area Wide Management (AWM) project

In 2001, the implementation of Area Wide Management of fruit flies in endemic areas was identified as high priority during a national fruit fly research and development meeting. A Horticulture Australia Limited (HAL) commissioned feasibility study identified the Central Burnett as having the highest potential for successful implementation of such a program.

The Central Burnett project (HAL Project AHO3002) was approved and ran from July 2003 to May 2007. A total of $3.3 million was allocated to the project over 3 years. The aims of the project were:

- To improve fruit fly control across the entire district by implementing additional control strategies in commercial orchards and by implementing controls in the town areas for the first time.

- To use AWM as a component in a systems approach to achieving quarantine security to current interstate and export markets.

2.1 Project outcomes

One of the main aims of the AWM program was to enhance market access opportunities in general for all fruit fly host commodities in the Central Burnett. For citrus, a specific aim was to implement an additional risk management measure as the basis for negotiating wider acceptance of ICA-28 for interstate trade.

If the ICA-28 is extended, then the possible decision by the APVMA to ban the use of dimethoate as a post-harvest treatment for citrus will have no effect on the Queensland citrus industry.

3. Methodology

This section will outline the methodologies used in calculating the results of this study.

3.1 Conditions used for analysis

The Central Burnett produces citrus of varying quality which is sold on the domestic and export markets. First and second grade fruit is sold to both domestic and export markets. A premium is paid to growers for fruit sold on the domestic market, due to lower transport costs compared to exported fruit. There is potential to increase supply of citrus to export markets in Asia.

Fruit is generally sent to one of the large marketing groups (Gayndah Packers or Sweetee), where the fruit is graded, treated, packed and marketed. As the procedure of dipping fruit in dimethoate is part of a larger system of marketing the fruit, the cost of the post-harvest dimethoate treatment is considered to be negligible (Graham Mcosker 2007, pers. comm.).

There is an 85 per cent probability that post harvest use of dimethoate will be disallowed or made conditional by type for citrus, by the APVMA (Chris Adrianson 2007, pers. comm. 2007). In this study a window of 5 years 2006-2011 was used as the probable time frame for this decision to be made. Over this time frame there will be a cumulative probability of occurrence, and in 2011 onwards the full impact of the decision will be felt (100 per cent).

As there is no data relating to post harvest residue levels of dimethoate on citrus, it is assumed the APVMA will take a precautionary approach to decision making. There is higher likelihood that post harvest use of dimethoate will be disallowed for mandarins than for other citrus due to the low skin to fruit ratio (Chris Adrianson 2007, pers. comm.). Lemons, limes, oranges and grapefruits have thicker skin and therefore there is a lower risk of ingestion of residue.

Due to the AWM project there is a 70 per cent probability that the ICA-28 will be extended to include at least one other state (Annice Lloyd 2007, pers. comm.). Without AWM there was only a 20 per cent probability of the extension of ICA-28. The proposal for the extension of ICA-28 was put forward during a meeting of the Domestic Quarantine and Market Access Group in May 2007 (Cameron Tree 2007, pers. comm.). The SA, WA and Tasmanian groups are seriously considering this

proposal, and SA is considered to be the most likely to accept in the near future. In this study, it is assumed that the ICA decision will occur before the APVMA decision, and will not change in the short term.

Other citrus producing regions of Queensland that have not implemented AWM have not been considered in this study. It is likely that if they were to adopt the AWM technology the results calculated in this study would be underestimating the benefits to the industry.

3.2 Applying state contingency approach

There is a risk that the Queensland citrus industry could lose access to some domestic markets if the APVMA decides to ban the post-harvest use of dimethoate. It is hoped that the implementation and continuation of AWM will assist in the negotiations to extend the ICA-28 so that the APVMA decision will not have a negative effect on the citrus industry. However, this outcome is not guaranteed, and there is a risk that these negotiations will not succeed.

The implications of the loss of these markets could include:

- A decrease in domestic demand for Queensland citrus, which will lead to an oversupply in the remaining markets, and may lead to fruit being sold at unviable prices.

- The increase in the amount of fruit sent to export markets where the price is lower, which will oversupply the market and lead to further price decreases.

3.2.1 Possible scenarios

The potential outcomes of the ICA-28 negotiations can be described as best, middle or worst case in so far as economic outcomes to Queensland producers are concerned. These have been outlined below:

Best Case:	Extension of ICA-28 to all other States
Middle Case:	Extension of ICA-28 to SA only
Worst Case:	No extension of ICA-28

The potential impact of an APVMA decision on the Queensland citrus industry could vary from no impact, to medium or high impact, depending on the ruling. The states of nature of this decision could be:

No impact:	Dimethoate allowed for use with all citrus (as at present)
Medium impact:	Dimethoate banned for use with mandarins
High impact:	Dimethoate banned for use with all citrus

The possible states of nature outlined above were applied to a decision tree to identify the scenarios. Scenario 1 in this case is describing the outcome in which no change will occur to the citrus industry as a result of these two decisions. Scenario 2, 3, 4 and 5 each vary in their impact depending on the state of nature of the outcome. With the

scenarios identified, they can now be organised into a generalised pay off matrix (Table 3.1).

Table 3.1 IRA pay off matrix

Outcome of ICA negotiations	Outcome of APVMA decision		
	No impact	Medium impact	High impact
Best case	Scenario 1	Scenario 1	Scenario 1
Middle case	Scenario 1	Scenario 2	Scenario 3
Worst case	Scenario 1	Scenario 4	Scenario 5

The probability of occurrence for each scenario needs to be estimated for the industry with and without AWM. The probabilities are based on estimates of industry experts, which are outlined in the assumptions of this paper.

With AWM there is a higher probability that either the best or middle case outcome will result from the ICA negotiations (70 per cent) than without AWM (20 per cent). Therefore the only difference between the industry forecast with and without AWM is the probabilities of occurrence for each scenario.

Table 3.2 IRA payoff matrix probabilities with AWM

Outcome of ICA negotiations	Outcome of APVMA decision			
	No impact	Medium impact	High impact	Total probability
Best case	3%	9%	8%	20%
Middle case	8%	23%	20%	50%
Worst case	5%	14%	12%	30%
Total probability	15%	45%	40%	100%

Table 3.3 IRA payoff matrix probabilities without AWM

Outcome of ICA negotiations	Outcome of APVMA decision			
	No impact	Medium impact	High impact	Total probability
Best case	1%	2%	2%	5%
Middle case	2%	7%	6%	15%
Worst case	12%	36%	32%	80%
Total probability	15%	45%	40%	100%

The next step is to determine the impact, in dollar terms, of each of these scenarios on the Central Burnett citrus industry. The impact is measured as the difference in producer surplus between the "no change" Scenario 1 and each of the other four scenarios. The change in producer surplus was found by modelling the industry under the conditions of the different scenarios, and is explained in the next section.

4. Project benefits

AWM increases the certainty of domestic market access because it underpins the extension of ICA-28 to other states, which will in turn mitigate the risk of losing markets in the case that post-harvest use of dimethoate is banned by the APVMA.

Therefore the benefit of AWM is the value of potential loss mitigation, because there is less chance of a negative outcome with AWM compared to without AWM.

The extent of the impact is found by calculating the change in producer surplus for each scenario, and applying the corresponding probability of occurrence with and without AWM. The sum of these values will give the estimated impact on industry of the APVMA decision with and without AWM, and the difference is the value of the benefit of AWM to the Central Burnett citrus industry.

4.1 Measurement of producer and consumer surplus

A surplus is generated when a consumer is able to buy a unit of a good at a price lower than her willingness to pay for that unit, or when a producer is able to sell a unit of a good or factor of production at a price higher than that at which he would willingly part with that unit (Campbell and Brown, 2005). The concept of producer and consumer surplus is used by economists as a way to measure changes in economic welfare.

Consumer surplus is a measure of the benefit received by the consumer, or the difference between what the consumer is willing to pay and what the consumer has to pay. Producer surplus is the amount producers receive above and beyond the minimum price that would be required to get them to produce and sell their output (Mansfield, 1997). In this study the long run minimum price has been used, which is the fixed cost of production. To illustrate, the producer surplus from the production and sale of the equilibrium output of a good is shown by the shaded area- the area above the supply curve and below the price (Figure 4.1).

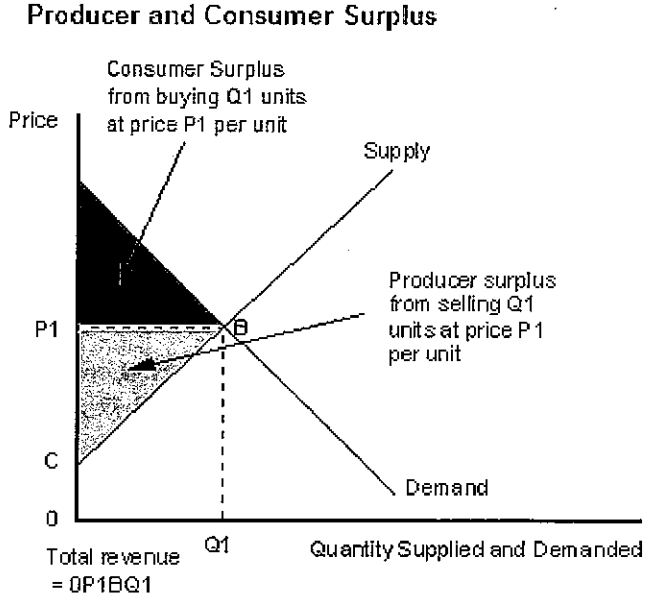

Figure 4.1 Producer and consumer surplus
Source: Mansfield 1997

4.1.1 Determining the impact on the industry

Each scenario will displace different quantities of fruit, which will need to be diverted from the lost markets to the remaining markets. The total quantities of fruit being traded from Queensland will not change in the short run as a result of the decisions; however quantities to the remaining domestic and international markets will increase as a result of the redirection. In this study the changes in surplus are calculated on an annual basis.

The loss of markets as a result of the APVMA decision would lead to an overall downward shift in the domestic demand curve for citrus. This will lead to the redistribution of fruit which is equivalent to an outward pivot in the supply curve of the other markets, for example the shift from supply 1 to supply 2, and therefore a change in consumer and producer surplus (Figure 4.2).

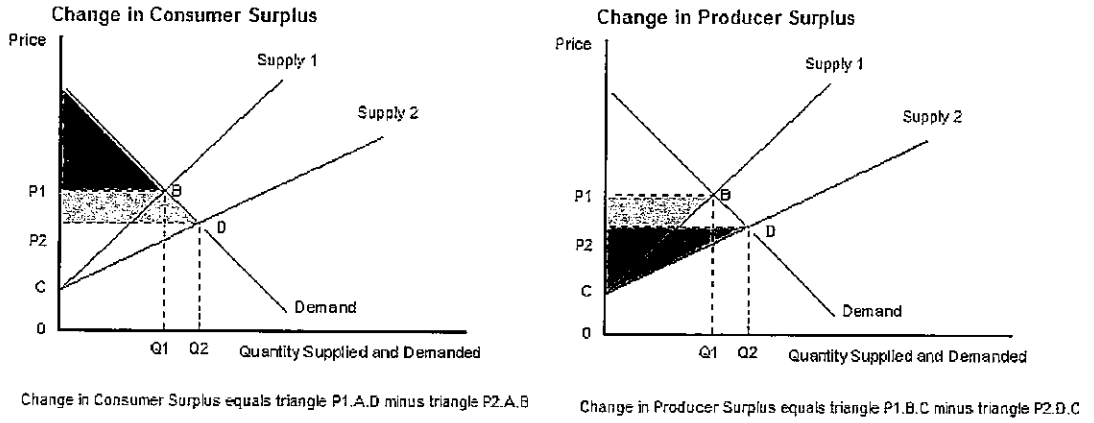

Figure 4.2 Shift in supply, leading to change in producer and consumer surplus
Source: Mansfield 1997

This redistribution will affect Australian consumers of Queensland citrus. It will lead to short term positive changes in consumer surplus in some States, where there is a surplus of fruit and the price is lower (QLD, NSW and Victoria). However there will be short term negative changes in consumer surplus in the States where Queensland fruit is no longer allowed (SA, WA and Tasmania) because the shock of the reduced supply of citrus would increase prices. These changes will be short term because the industry is likely to undergo structural adjustment in order to restore the balance of supply and demand. For example, South Australian citrus producers are likely to divert more citrus from export markets to the domestic market (where the price is higher) as a result of a block on Queensland citrus. Similarly the Queensland citrus industry would need to expand their markets, both export and domestic, or cut back production. Changes in consumer surplus are likely to be short term, and the positive and negative changes in different States will cancel each other out. As this study is using a project BCA the consumer surplus has not been quantified or used, as it is not considered a direct project output.

The redistribution of fruit will lead to subsequent increases in quantity supplied to the remaining markets and decreases in price. The extent of these changes to producer surplus is measured using the own-price elasticities of demand and supply.

4.1.2 Own price elasticity

Price elasticity can be interpreted as the percentage change in quantity demanded/supplied given a percent change in the price of that commodity, ceteris paribus. If elasticity of demand for a commodity is price elastic (|E|>1), an increase in the quantity supplied will mean that percentage decrease in the price the consumers are willing to pay for the commodity will be smaller than the percentage increase in supply. If the elasticity of demand for a commodity is inelastic (|E|<1) there will need to be a greater percentage drop in price in order to encourage consumers to increase consumption to accommodate an increase in quantity supplied. The formula for own price elasticity of demand (OPED) of demand is given by:

$$OPED = \frac{(Q2 - Q1)/((Q1 + Q2)/2)}{(P2 - P1)/((P1 + P2)/2)}$$

where: $P1$ is the original price
$P2$ is the new price
$Q1$ is the original quantity
$Q2$ is the new quantity.

This equation is used to determine the new equilibrium price as a result of a change in quantity or vice versa.

4.1.3 Citrus marketing information

Marketing information for citrus in the Central Burnett was gathered through consultation with industry representatives as well as literature reviews. For the purpose of this study citrus was split into two groups: mandarins, and other, which is made up of oranges, lemons, limes and grapefruit. The prices used are meant to be a general representation of prices producers can expect for produce in an average year. Prices are known to fluctuate seasonally, and the figures given in Table 4.1 have been chosen after discussions with the Queensland Citrus Growers Inc, as well as Policy and Investment Advice[1]. Mandarin export price was determined from export data from the Australian Citrus Growers Inc.

Table 4.1 Marketing information for citrus from the Central Burnett

	Mandarins	Other
Price	**($/t)**	**($/t)**
Domestic	1 500	1 350
Export	1 300	1 250
Processing	30	30
Break even	1 000	900
Costs	**($/t)**	**($/t)**
Fixed cost of production	368	368
Elasticities of demand		
Domestic	-0.8	-1.44
Export	-1.44	-1.44

Source: Sparks 1992, Jetter et al 2000, QLD Citrus Growers 2007, QDPI 2007.

[1] It should be noted that information on market prices is not easily attainable from the industry due to its fragmented nature.

4.1.4 Citrus production and distribution of sales

The Queensland citrus industry was estimated to produce 100,000 tonnes of citrus in 2006, and is worth approximately $120 million. The Central Burnett region generally produces about 80 per cent of Queensland production. Around 70 per cent of Queensland citrus production is mandarins, which is worth close to $90 million (Table 4.2).

Table 4.2 Estimated quantities of citrus production 2006

Production of citrus	Queensland		Central Burnett	
	All	Mandarin	All	Mandarin
Percentage of Production (%)	100%	70%	100%	70%
Production (t)	100,000	70,000	80,000	56,000
Estimated GVP ($)	123,640,000	86,548,000	99,912,000	70,985,600

The destination of sales of citrus to the three markets is shown in Table 4.3. Sixty per cent of first and second grade fruit is sold on the domestic market at a premium price. The export market receives about 28 per cent of citrus from the area. Any fruit that is deemed not suitable for sale is sent to processing plants to be converted to juice or other products. This is not considered a viable market as producers are only paid a salvage price for this fruit, which is generally the cost of transport. In the Central Burnett this is about 12 per cent of production, which is much lower than that of coastal areas.

Table 4.3 Destination of sales of all citrus from the Central Burnett

Destination of sales (all citrus)		Quantity	Value
Domestic markets	%	tonnes	$'000
NSW	30%	14,400	19,325
QLD	25%	12,000	16,104
Victoria	25%	12,000	16,104
SA	15%	7,200	9,662
Tasmania, WA	5%	2,400	3,221
Total domestic	100%	48,000	64,416
Domestic % of total	60%	48,000	64,416
Export % of total	28%	22,400	28,784
Processing % of total	12%	9,600	288
Total	100%	80,000	93,488

5. Project costs

The costs of AWM included in this study include the initial investment costs of the pilot project as well as the ongoing costs to maintain the program. The main sources of funding have been the DPI&F, HAL and Central Burnett Shire Councils and producers.

5.1 Costs of the Central Burnett AWM scheme

The total cost of the pilot project over the three years (2004 to 2006) was $2.4 million in constant dollar figures. This figure was based on the total HAL funds for the research project plus the value of other contributions from DPI&F, the Central Burnett Shire Councils, and the cost to growers to implement the additional control strategy (MAT) which was initiated as a component in the AWM program. The cost to

producers for orchard treatments (e.g. baiting) and consultant services which were already being undertaken prior to the commencement of AWM were not included as a cost for the purposes of this analysis.

6. Results

6.1 Impact of AWM on the Queensland citrus industry

The annual change in producer surplus associated with each scenario is shown in Table 6.1. Scenario 1 is taken as the status quo, representing no change to the industry as a result of the APVMA decision. The change in producer surplus is the difference between the producer surplus of each scenario and that of scenario 1. The workings and explanations of these calculations can be found in Appendix 1 and Appendix 2. In the case that ICA-28 is not extended to any other states the loss to the citrus producers would be $5.5 million if dimethoate is disallowed for mandarins and $7 million if dimethoate is disallowed for all citrus. If ICA-28 is extended to SA, under the same APVMA decisions there will be a loss of $1.66 million and $3.7 million respectively.

Table 6.1 IRA payoff matrix: Effect of scenarios on producer surplus

Outcome of ICA negotiations	Outcome of APVMA decision		
	No impact	Medium impact	High impact
	$'000	$'000	$'000
Best case	0	0	0
Middle case	0	- 1,658	- 3,707
Worst case	0	- 5,526	- 7,142

The annual total value of risk to the industry, as a result of the APVMA decision with and without AWM, can be found by weighting the value of each scenario with its corresponding probability (Table 3.2 and Table 3.3). The sum of the values of each of these scenarios gives a total value of losses to producer surplus in the citrus industry as a result of the APVMA decision (Table 6.2 and Table 6.3).

Table 6.2 Payoff matrix with AWM: Effect of scenarios with probabilities

Outcome of ICA negotiations	Outcome of APVMA decision			
	No impact	Medium impact	High impact	
	$'000	$'000	$'000	$'000
Best case	0	0	0	
Middle case	0	- 373	- 402	
Worst case	0	- 746	- 856	
SUM				- 2,378

Table 6.3 Payoff matrix without AWM: Effect of scenarios with probabilities

Outcome of ICA negotiations	Outcome of APVMA decision			
	No impact	Medium impact	High impact	
	$'000	$'000	$'000	$'000
Best case	0	0	0	
Middle case	0	- 112	- 121	
Worst case	0	- 1,990	- 2,285	
SUM				- 4,507

With AWM there is a lower probability of occurrence of the worst case scenario, and the value of the risk to the industry decreases to $2.4 million per year. Without AWM the sum of these losses is $4.5 million per year. Therefore the expected benefit of AWM to the Queensland citrus industry is $2.1 million.

6.2 State contingent analysis: Multi-period benefit

In order to apply this information over several years, it is necessary to determine the general timeframes in which the ICA and the APVMA decision will be made. It is assumed that the APVMA decision is likely to be made within the five year window between 2007 to 2011 (Chris Adrianson 2007, pers. comm.). Over this period the sum of the probability of occurrence is 100 per cent. After 2011 it is assumed that the decision would have been made and the Queensland citrus industry will be feeling the full impact (100 per cent) on an annual basis. The annual benefits of AWM over 10 years taking into account the probability of occurrence the APVMA decision are shown in Table 6.4.

Table 6.4 APVMA decision

Year	Probability that result of APVMA decision will apply	Annual benefit of AWM over 10 years
		$'000
2004	0%	0
2005	0%	0
2006	0%	0
2007	5%	107
2008	15%	319
2009	50%	1,064
2010	75%	1,596
2011	100%	2,128
2012	100%	2,128
2013	100%	2,128
2014	100%	2,128

The annual project benefits were found by applying the annual probability of occurrence of the APVMA decision with the expected annual benefit of AWM (Appendix 3). These can now be applied to the BCA.

It has been assumed that the ICA decision will be made before the APVMA decision. Although these decisions are independent of one another, if the APVMA decision proves to be detrimental to any of the States (SA, WA, and Tasmania) it is likely that this will lead to the adoption of ICA-28 and therefore re-enable trade of Queensland citrus. This possibility has not worked into this model.

6.3 Benefit cost analysis

The present yearly benefits and costs of the AWM project for the years 2004 to 2014 are presented in Table 6.5. All benefits and costs have been discounted/ compounded to 2007 values using a 5 per cent discount rate.

Table 6.5 The present value of benefits and costs of the AWM over 10 years (2004-14)

Year	Present value of project benefits	Present value of project costs	Net present value of project
	$	$	$
2004	0	1,015	-1,015
2005	0	861	-861
2006	0	797	-797
2007	106	208	-102
2008	304	198	106
2009	965	189	777
2010	1,379	180	1,199
2011	1,751	171	1,580
2012	1,668	163	1,505
2013	1,588	155	1,433
2014	1,513	148	1,365
Total	9,274	4,085	5,189

At a discount rate of 5 per cent, research project costs of $4.1 million generated benefits of around $9.3 million. This has resulted in a positive NPV of $5.2 million, and a benefit cost ratio of 2.27:1 (Table 6.6). The IRR of 18 per cent is well above the social discount rate of 5 percent and the project is deemed acceptable under this criteria.

Table 6.6 Profitability of the AWM research project and ongoing program

BCA parameters 2004-18	
	$'000
Total Present Value of producer benefits (A)	9,274
Total Present Value of R&D costs (B)	4,085
NPV of project (A-B)	5,189
BC ratio (A/B)	2.27:1
IRR	18%

6.4 Sensitivity analysis

6.4.1 Prices

The price paid for Queensland citrus on the domestic and export market is subject to change, and variability in prices is not yet taken account of in this analysis. The sensitivity of the results of this analysis to a change in export and domestic prices are shown in Table 6.7. The table shows the effect on the results from a 10 per cent and 20 per cent increase/decrease in prices.

Table 6.7 Sensitivity analysis using different levels of domestic and export prices

BCA Parameters	Decreased 20%	Decreased 10%	Base Case	Increased 10%	Increased 20%
2004-18	$'000	$'000	$'000	$'000	$'000
NPV of producer benefits (A)	7,419	8,346	9,274	10,201	11,129
NPV of R&D costs (B)	4,085	4,085	4,085	4,085	4,085
NPV of project (A-B)	3,334	4,261	5,189	6,116	7,044
BC ratio (A/B)	1.81:1	2.04:1	2.27:1	2.50:1	2.72:1
IRR	13%	15%	18%	20%	22%

As would be expected the NPV decreases with lower prices, and increases with higher prices. However it is important to note that even if prices decrease by 20 per cent the NPV of the AWM project remains positive.

6.4.2 Probabilities

Other variables assessed in the sensitivity analysis are the state contingency probabilities used in the 'with' and 'without' AWM. Probabilities used in the base case were based on estimates given by Annice Lloyd (2007 pers. comm.) and Chris Adriaansen (2007 pers. comm).

The sensitivity of this analysis to these probabilities is shown in Table 6.8. Scenario A explores the effect of a change in probabilities in the APVMA decision, which has minimal effect on the results of the analysis. Scenario B takes a pessimistic approach to the effect of AWM on affecting the ICA decision. The best and middle outcomes are both reduced by 10 per cent, and the worst case outcome is increased by 20 per cent. This has a significant effect on the results of the study, and causes decreased NPV. This highlights the importance of differentiating the probabilities of each state of nature as a result of specific variables. Scenario C considers the increased probability of best and middle outcomes of the ICA decision, with an expected higher NPV. Details of the sensitivity scenarios are in Appendix 4.

Table 6.8 Sensitivity analysis using different state contingency probabilities

BCA Parameters	Base Case	Scenario A	Scenario B	Scenario C
2004-18	$'000	$'000	$'000	$'000
NPV of producer benefits (A)	9 274	9 423	5 294	13 254
NPV of R&D costs (B)	4 085	4 085	4,085	4 085
NPV of project (A-B)	5 189	5 337	1 209	9 169
BC ratio (A/B)	2.27:1	2.31: 1	1.30:1	3.24:1
IRR	18%	18%	5%	26%

7. Discussion

The AWM project in the Central Burnett district has been used to mitigate the negative trade impact of the possible APVMA decision to disallow the use of dimethoate. The scope of this study has measured the benefits of this project over only a short period (eight years) because there is the likelihood of policy or industry changes in the medium term that cannot be fully taken account of in this study. If there was a negative effect on the Queensland citrus industry of losing domestic markets, and prices for citrus dropped, in the medium term it is likely that industry would adjust by producing less citrus. It is also probable that if South Australia, Western Australia or Tasmania were negatively affected by the inability to import

Queensland citrus, they may be more likely to reconsider the adoption of an ICA-28. Hence due to the possible industry and policy actions in the medium term, this study has focussed on the short term effect of AWM on the Queensland citrus industry.

This study is not without limitations. The main assumptions of the study have been based on events that have not yet occurred, hence the need for the risk approach of using probabilities. One of the main variables of this study was the probability of occurrence of best, middle or worst case outcomes from the ICA negotiations as a result of the AWM project. The probabilities used were justified as they came from industry experts and a sensitivity analysis was performed. When a pessimistic scenario was used, and the best and medium case probabilities were decreased 10 per cent the project still yielded a positive NPV. This highlights that the benefits of this project are evident even if it is considered in a pessimistic light. Despite the subjective nature of risk analysis, this does not detract from the usefulness of this analysis in determining the effect of AWM under a certain set of agreed conditions.

The AWM program is important for the citrus industry in Queensland as it has the ability to increase the probability of the best case scenario resulting from the ICA negotiations. However AWM will have no effect on the APVMA decision. In order to increase the probabilities of "no impact" on the citrus industry as a result of the APVMA decision on dimethoate, it would be beneficial for the citrus industry to conduct research into the acute reference dose (ARD) of dimethoate on fruit after post harvest treatment. The APVMA is acknowledging research data from Europe that investigated the acceptable daily intake (ADI) of dimethoate on different fruits after pre-harvest treatments. However, there is currently no data on the acute reference dose (ARD) of dimethoate on fruit after post-harvest treatment, and therefore the APVMA will be more likely to rule against its use based on the precautionary principle.

8. Conclusions

This study has found that the AWM program has the potential to dramatically reduce the negative impact of the removal of dimethoate on the citrus industry. Under this assumption the benefit of mitigating the risk to the industry of the loss of dimethoate has been quantified.

Without AWM the removal of dimethoate by the APVMA would cost the Central Burnett citrus industry around $4.5 million due to the loss of access to domestic markets. With AWM the probability of a worst case scenario decreases and the same decision on dimethoate would cause losses of $2.4 million. Although the AWM project will not prevent the removal of dimethoate, it will reduce the negative impact on the industry by $2.1 million for each year after the APVMA decision has been made.

At a discount rate of 5 percent, the NPV of the AWM project over 10 years was found to be $5.2 million, with an IRR of 18 per cent, and a BCR of 2.27:1. These results indicate that the project is of net benefit to Central Burnett producers and the investment costs can be justified.

It should be clearly noted that the full benefits of AWM have not been calculated in this study. The AWM program in the Central Burnett provides benefits to all horticultural commodities affected by fruit fly, while this study has focussed purely on its effect to the citrus industry. However through this study it has been shown that the program is cost efficient even without all benefits included. It can therefore be assumed that the overall value of this program would be higher than that calculated in this study.

9. References

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Appendix 1: Calculation of scenarios

Scenario 1			
Premium			
P1m	1,500	TRm	$50,400,000
Q1m	33,600	PSm	$19,017,600
P1o	1,350	TRo	$19,440,000
Q1o	14,400	PSo	$7,070,400
Export			
P1m	1,300	TRm	$20,384,000
Q1m	15,680	PSm	$7,306,880
P1o	1,250	TRo	$8,400,000
Q1o	6,720	PSo	$2,963,520
Processing			
P1m	30	TRm	$201,600
Q1m	6,720	PSm	-$1,135,680
P1o	30	TRo	$86,400
Q1o	2,880	PSo	-$486,720
Total TRm	$70,985,600		
TotalTRo	$27,926,400		
Total PSm	$25,188,800		
Total Pso	$9,547,200		
Total TR	$98,912,000		
Total PS	$34,736,000		

Scenario 2			
Premium			
EoD	-0.8		
P1m	1,500	TRm1	$47,880,000
P2m	1,401	TRm2	$47,084,211
Q1m	31,920	PSm1	$18,066,720
Q2m	33,600	PSm2	$17,359,705
Export			
EoD	-1.44		
P1m	1,300	TRm1	$20,384,000
P2m	1,300	TRm2	$20,384,000
Q1m	15,680	PSm1	$7,306,880
Q2m	15,680	PSm2	$7,306,880
Processing			
P1m	30	TRm1	$201,600
Q1m	6,720	PSm1	-$1,135,680
Total TRm	$68,465,600		
TotalTRo	$27,926,400		
Total PSm	$23,530,905		
Total Pso	$9,547,200		
Total TR	$96,392,000		
Total PS	$33,078,105		

Scenario 4			
Premium			
EoD	-0.8		
P1m	1,500	TRm1	$40,320,000
P2m	1,300	TRm2	$38,671,360
Q1m	26,880	PSm1	$15,214,080
Q2m	29,747	PSm2	$13,862,195
Export			
EoD	-1.44		
P1m	1,300	TRm1	$20,384,000
P2m	1,078	TRm2	$21,059,769
Q1m	15,680	PSm1	$7,306,880
Q2m	19,533	PSm2	$6,935,849
Processing			
P1m	30		
Q1m	6,720	TRm1	$201,600
		PSm1	-$1,135,680
Total TRm	$60,905,600		
TotalTRo	$27,926,400		
Total PSm	$19,662,364		
Total Pso	$9,547,200		
Total TR	$88,832,000		
Total PS	$29,209,564		

Scenario 3			
Premium			
EoDm	-0.8		
P1m	1,500	TR1m	$47,880,000
P2m	1,401	TR2m	$47,084,211
Q1m	31,920	PS1m	$18,066,720
Q2m	33,600	PS2m	$17,359,705
EoDo	-1.44		
P1o	1,350	TR1o	$18,468,000
P2o	1,301	TR2o	$18,729,474
Q1o	13,680	PS1o	$6,716,880
Q2o	14,400	PS2o	$6,715,137
Export			
EoDm	-1.44		
P1m	1,300	TR1m	$20,384,000
P2m	1,300	TR2m	$20,384,000
Q1m	15,680	PS1m	$7,306,880
Q2m	15,680	PS2m	$7,306,880
EoDo	-1.44		
P1o	1,250	TR1o	$8,400,000
P2o	1,250	TR2o	$8,400,000
Q1o	6,720	PS1o	$2,963,520
Q2o	6,720	PS2o	$2,963,520
Processing			
P1m	30	TR1	$201,600
Q1m	6,720	PS1	-$1,135,680
P1o	30	TR1	$86,400
Q1o	2,880	PS1	-$486,720
Total			
TRm	$67,669,811		
TotalTRo	$27,129,474		
Total			
PSm	$23,530,905		
Total Pso	$9,191,937		
Total TR	$94,799,284		
Total PS	$32,722,842		

Scenario 5			
Premium			
EoDm	-0.8		
P1m	1,500	TR1m	$40,320,000
P2m	1,300	TR2m	$38,671,360
Q1m	26,880	PS1m	$15,214,080
Q2m	29,747	PS2m	$13,862,195
EoDo	-1.44		
P1o	1,350	TR1o	$15,552,000
P2o	1,250	TR2o	$15,936,000
Q1o	11,520	PS1o	$5,656,320
Q2o	12,749	PS2o	$5,622,221
Export			
EoDm	-1.44		
P1m	1,300	TR1m	$20,384,000
P2m	1,078	TR2m	$21,059,769
Q1m	15,680	PS1m	$7,306,880
Q2m	19,533	PS2m	$6,935,849
EoDo	-1.44		
P1o	1,250	TR1o	$8,400,000
P2o	1,037	TR2o	$8,678,476
Q1o	6,720	PS1o	$2,963,520
Q2o	8,371	PS2o	$2,798,937
Processing			
P1m	30	TR1	$201,600
Q1m	6,720	PS1	-$1,135,680
P1o	30	TR1	$86,400
Q1o	2,880	PS1	-$486,720
Total			
TRm	$59,932,729		
TotalTRo	$24,700,876		
Total			
PSm	$19,662,364		
Total Pso	$7,934,438		
Total TR	$84,633,605		
Total PS	$27,596,803		

Key to the calculation of scenarios

P1 (m/o)Initial price paid for mandarin/other citrus
P2 (m/o) Price paid after redistribution to remaining markers for mandarin/other citrus
Q1 (m/o) Initial quantity sold of mandarin/ other citrus
Q2 (m/o) Quantity sold after redistribution to remaining markers for mandarin/other citrus

EoD Elasticity of demand
TR (m/o) Total revenue for mandarin/ other citrus
PS (m/o)Producer surplus for mandarin/ other citrus

Appendix 2: Scenarios description

This section briefly describes the method by which change in producer surplus was found for the five scenarios.

Scenario 1 assumes that the current market distribution of citrus will remain the same. Therefore there will be no change to prices, quantities or producer surplus for any market. This scenario will occur either because: the decision is made to extend ICA-28 to SA, WA and Tas, therefore making irrelevant the APVMA decision; or the decision from the APVMA is to allow post-harvest use of dimethoate, therefore allowing the citrus industry to behave as normal. Producer surplus in this base scenario is $31.38 million.

Scenario 2 assumes that ICA-28 is extended to SA, and that the APVMA decision rules to disallow post-harvest dimethoate treatment for mandarins. Therefore there will need to be a redistribution of 1,680 tonnes of mandarins from WA and Tas to other markets. In this case the addition of 1,680 tonnes to the remaining domestic market for mandarins caused a decrease in price from $1,500/t to $1,401/t, and there is no change to the export or processing markets. Producer surplus falls by $1.66 million per year, compared to Scenario 1.

Scenario 3 assumes that ICA-28 is extended to SA, and that the APVMA decision rules to disallow post-harvest dimethoate treatment for all citrus. Therefore there will need to be a redistribution of 1,680 tonnes of mandarins and 720 tonnes of other citrus from WA and Tasmania to other markets. In this case the 1,680 tonnes mandarin goes to the domestic market. The excess 720 tonnes of other citrus is redistributed to the remaining domestic market causing a decrease in domestic price from $1,350/t to $1,301/t. Producer surplus falls by $3.71 million per year, compared to Scenario 1.

Scenario 4 assumes that ICA-28 is not extended to any other States, and that the APVMA decision rules to disallow post-harvest dimethoate treatment for mandarins. Therefore there will need to be a redistribution of 6,720 tonnes of mandarins from SA, WA and Tasmania to other markets. In this case the mandarins are redistributed to the remaining domestic market to the point where domestic price $1,500/t equals export price $1,300/t (2,867 tonnes). The remaining 3,853 tonnes of mandarins are then sold on the export market, with a subsequent fall in price from $1,300/t to $1,078/t. Producer surplus falls by $5.53 million per year, compared to Scenario 1.

Scenario 5 assumes that ICA-28 is not extended to any other States, and that the APVMA decision rules to disallow post-harvest dimethoate treatment for all citrus. Therefore there will need to be a redistribution of 6,720 tonnes of mandarins and 2,880 tonnes of other citrus from SA, WA and Tasmania to other markets. In this case the 6,720 tonnes of mandarin is redistributed to the domestic and export market as in scenario 4. The other citrus is redistributed to the remaining domestic market to the point where domestic price $1,350/t equals export price $1,250/t. Due to the relatively inelastic nature and smaller size of the remaining market for other citrus, this only accommodates 307 tonnes. The remaining 2,573 tonnes of other citrus is redistributed to the export market to the point where export price $1,250/t falls to $918/t (2720 tonnes). Producer surplus falls by $7.14 million per year, compared to Scenario 1.

Appendix 3: State contingent analysis: Multi-period benefit

	Year	Best case	Middle case			Worst case			Benefit of AWM	Probability that result of APVMA decision will apply
			None	Medium	High	None	Middle	High		
		$	$	$	$	$	$	$	$	%
2004	1	0	0	0	0	0	0	0	0	0
2005	2	0	0	0	0	0	0	0	0	0
2006	3	0	0	0	0	0	0	0	0	0
2007	4	0	0	-13,056	-14,092	0	62,172	71,392	106,416	5
2008	5	0	0	-39,168	-42,276	0	186,517	214,176	319,249	15
2009	6	0	0	-130,559	-140,921	0	621,724	713,920	1,064,163	50
2010	7	0	0	-195,839	-211,382	0	932,586	1,070,880	1,596,245	75
2011	8	0	0	-261,118	-281,842	0	1,243,448	1,427,839	2,128,327	100
2012	9	0	0	-261,118	-281,842	0	1,243,448	1,427,839	2,128,327	100
2013	10	0	0	-261,118	-281,842	0	1,243,448	1,427,839	2,128,327	100
2014	11	0	0	-261,118	-281,842	0	1,243,448	1,427,839	2,128,327	100

Appendix 4: Sensitivity scenarios: Probability

Scenario A

With AWM	Outcome of ICA negotiations	Outcome of APVMA decision			
		None	Medium	High	
	Best case	3%	8%	9%	20%
	Middle case	8%	20%	23%	50%
	Worst case	5%	12%	14%	30%
		15%	40% ↓	45% ↑	100%

Without AWM	Outcome of ICA negotiations	Outcome of APVMA decision			
		None	Medium	High	
	Best case	1%	2%	2%	5%
	Middle case	2%	6%	7%	15%
	Worst case	12%	32%	36%	80%
		15%	40% ↓	45% ↑	100%

Scenario B

With AWM	Outcome of ICA negotiations	Outcome of APVMA decision			
		None	Medium	High	
	Best case	2%	5%	4%	10% ↓
	Middle case	6%	18%	16%	40% ↓
	Worst case	8%	23%	20%	50% ↑
		15%	45%	40%	100%

Without AWM	Outcome of ICA negotiations	Outcome of APVMA decision			
		None	Medium	High	
	Best case	1%	2%	2%	5%
	Middle case	2%	7%	6%	15%
	Worst case	12%	36%	32%	80%
		15%	45%	40%	100%

Scenario C

With AWM	Outcome of ICA negotiations	Outcome of APVMA decision			
		None	Medium	High	
	Best case	5%	14%	12%	30% ↑
	Middle case	9%	27%	24%	60% ↑
	Worst case	2%	5%	4%	10% ↓
		15%	45%	40%	100%

Without AWM	Outcome of ICA negotiations	Outcome of APVMA decision			
		None	Medium	High	
	Best case	1%	2%	2%	5%
	Middle case	2%	7%	6%	15%
	Worst case	12%	36%	32%	80%
		15%	45%	40%	100%