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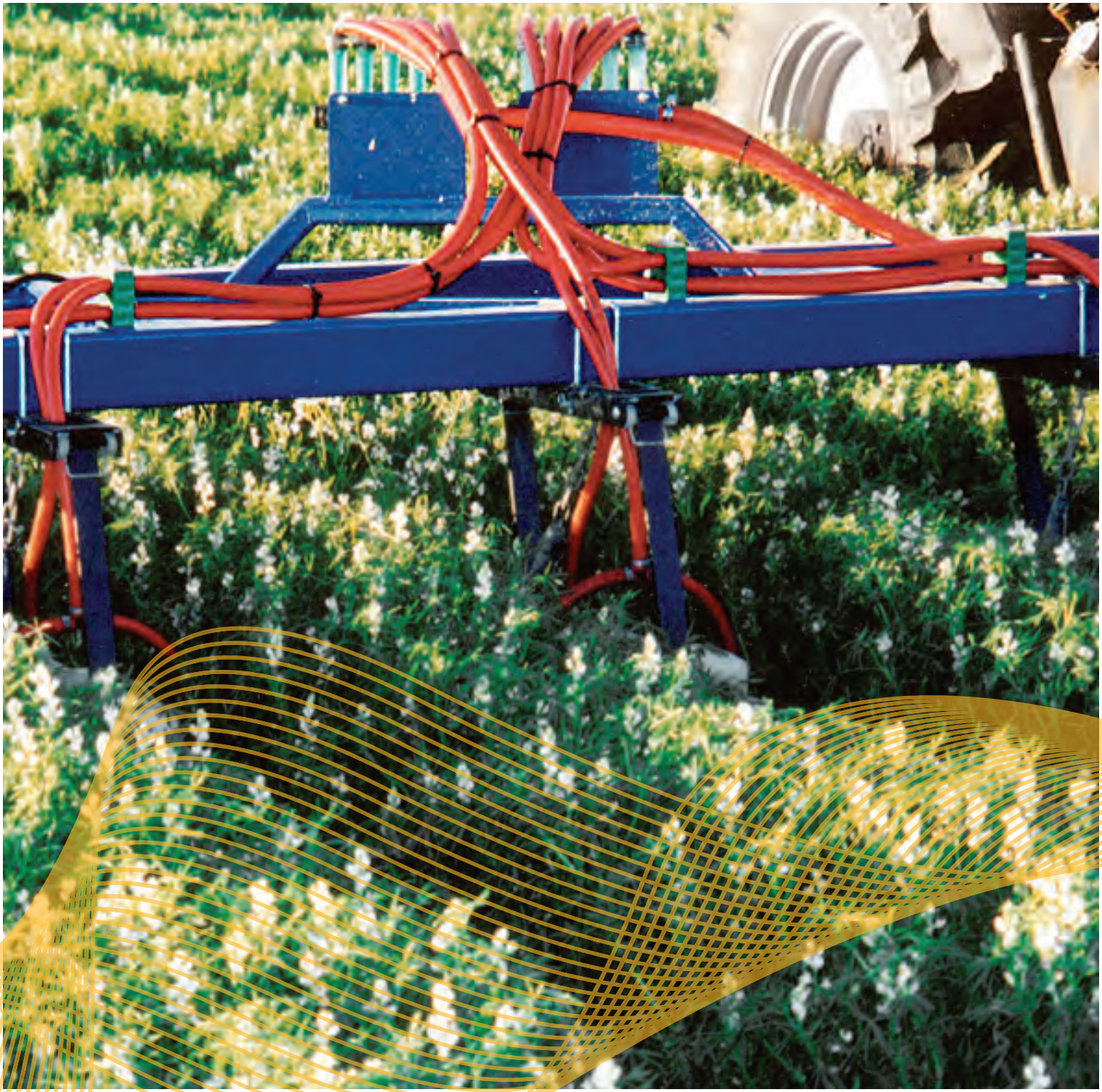
An Economic Analysis of GRDC Investment in Minor Use Chemicals



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Impact Assessment: An Economic Analysis of the GRDC Investment in Minor Use Chemicals

Executive Summary

The GRDC Minor Use projects (MUP) grew out of concerns by Pulse Australia in the mid 1990s that growers of pulses had limited access to the pesticides needed for sustainable production. The implications of off-label use were a growing threat; pulse production was expanding and community concerns on pesticide use were increasing. The risk of pesticide residues damaging the enviable reputation enjoyed by Australian grain and meat exports was another key factor as the domestic feedgrain market expanded. The MUP assisted in the issuing of permits for a wide range of minor crops particularly pulses and oilseeds. The evaluation, although based on arguable assumptions, indicated a very high return to the $3.2 million investment (present value basis) over the period from 1998/1999 to 2009/10; the benefit-cost ratio was estimated to be over 13 to 1.

The first MUP project began in 1998 and was followed by a further five projects to 2010 covering all GRDC minor crops, minor uses in major crops, and emergency permits. There is one current continuing project not included in this evaluation. The MUP secured numerous permits to give growers access to chemicals where chemical companies considered it uneconomic for them to do so because of the size of the market and because of the costs of registration. Over one half of the 25 grain crops subject to GRDC research levies are classified as minor crops. Lack of good options for pest control was a serious brake on the viability of many of the minor crops. From a grain industry perspective, minor crops have a vital role in creating diversity. They have a key role in sustaining a resilient agriculture able to respond to adverse impacts to regions and to specific crops.

The evaluation was inherently problematic because of the difficulty of postulating what difference MUP made. At one extreme, it could have been assumed that growers at the start of MUP in 1998 would continue 'business as usual' and make widespread use of chemicals they previously used off-label. There would then be little change in profitability if the same chemicals were available under a permit system. At the other extreme, it could be assumed that the capacity to use chemicals available under permit would have enabled losses due to disease to be avoided and made production of the crops involved more profitable and less risky.

The evaluation clearly hinges on assumptions on what growers would have done in the absence of MUP. The assumption in this evaluation is that in the main and in the short term, growers would have continued to use the same pesticides as they had been using. But the off-label use would typically have been by experienced growers using pesticides registered for use on similar crops against similar pests. There are obvious difficulties in seeking evidence on behaviour a decade ago. Suffice to say that in initiating MUP, Pulse Australia stated that during the late 1990s growers *"were forced to use unregistered pesticides if they are to maintain profitable and sustainable production".*

The assumptions were also guided by increasing community and grain marketer concerns over the last decade on potential and perceived risks of pesticides in terms of food safety in particular and also to the environment. The analysis concentrated initially on three major pulse crops, chickpeas, faba beans and lentils which had disease loss data available for ascochyta. The benefits assessed were then scaled up to account for the other minor crops, particularly oilseeds. The pulse industry was highly dependent on the availability of fungicides to control ascochyta given the huge

losses that had been incurred, for example 100,000 ha of chickpeas devastated in Victoria in 1998. The two benefits assessed were for disease loss avoided and for increased profitability from crops displaced as pulses became more profitable. Both benefits were assumed to increase to a maximum by 2004 and then decline. It was assumed that in the absence of MUP, there would have eventually over the course of a decade been alternative ways developed to achieve registration of some key pesticides (pesticide use in agriculture has been subject to various reviews in recent years including approaches to regulation). In the absence of MUP, there would also have been increased research and grower adaptations on other means of disease control such as more resistant varieties and alternative break crops.

The benefits were assessed as increased net present value of close to $40 million from the investment of $3.2 million (present value), two thirds contributed by GRDC. The majority of the benefits assessed were from reduced losses achieved by a wider range of chemicals available for control of disease. But there were also considered to be substantial benefits from an increased area of pulses because of their greater profitability including their value as a break crop in cereal rotations. For example, the increased range of options that MUP provided for disease control contributed to the rapid expansion of chickpeas in the GRDC Northern Region.

There was a degree of confidence in the assumptions in a qualitative sense. However there was no data available on the extent of pesticide use before and after the introduction of permits for specific crops and uses. The quantitative assumptions are therefore subject to a high degree of uncertainty. Benefits not valued included the reduced risk of pesticide residues damaging the enviable reputation enjoyed by Australian grain and meat exports, and benefits to the environment.

An overview of benefits in a triple bottom line categorisation follows (as in Table 7 from Section 5).

Categories of Notable Benefits from the Cluster Investment

Benefit	Levy paying industry and its supply chain	Spillovers		
		Other industries	Public	Foreign
Economic	• Increased profitability and reduced risk from increased availability of more effective registered chemicals. • Continued maintenance of grain markets.	Reduced risk of MRL exceedance in industries based on grain industry products.	Improved industry input into government rural policy on chemical use.	Reduced trade risk of MRL exceedance in grain imports.
Environmental	More sustainable cropping from increase in pulses and in Quality Assurance.		Improved stewardship.	
Social	Reduced human health risk from chemicals.		Australian consumers receive safer grain products.	Foreign consumers receive safer grain products.

1. Introduction

Participants in the grain industry covering 25 leviable crops have a continuing need to access a wider range of chemicals for crop protection. Increasing inputs of chemicals for control of diseases, pests and weeds have been a major contributor to productivity gains and to more sustainable rotations based on a diversified mix of crops. During the 1990s there had been rapid expansion in areas of canola, other oilseeds and of pulse crops. There was also an increasing diversity of pest and disease problems. With manufacturers concentrating on major markets for pesticides there are many minor uses that need to be accommodated within the evolving regulatory framework. This impact study covers six projects funded in sequence from 1998 to 2010 to meet needs identified for improved access to chemicals for minor uses.

A more regulated approach to chemical use in Australian agriculture had its origins in a trade crisis in 1987. Detection of organochloride residues in export beef precipitated action. Regulation was based on State and National coordination and incorporated cost recovery. The first comprehensive grain industry project arose from a review by Pulse Australia which identified that growers of pulses had limited access to the pesticides needed for sustainable production. The capacity of the industry to meet objectives in terms of responsible use of registered pesticides and achieving quality assurance (QA) for their grain products were of increasing concern. Later projects were expanded to cover all grain crops where there were unmet priority needs for pesticides that could be met by minor use or emergency permits issued by APVMA (Australian Pesticides and Veterinary Medicines Authority, previously NRA, the National Registration Authority). In this report pesticides and chemicals are used as general terms which include chemicals with specific uses, particularly insecticides for control of invertebrate pests, weedicides or herbicides, desiccants and fungicides. Permits are based on risk assessments where "*risk has the meaning of the likelihood of harm in the circumstances of its use*."

As APVMA (2008) stated "In general, minor crops are those where the costs involved in generating data (for example on residues, efficacy, environmental and worker safety data) for registration of a minor use are not recouped from the market". Minor uses are administered using off-label permits for a use not on the label. Permits are for a specified duration and lead in some cases to extension of labels to cater for new uses or to renewal of the permit. During 2009/10 broadacre crops accounted for 10 percent of the minor use permits issued (APVMA, 2010). Minor uses can be for crops other than defined major crops, or for minor use in major crops (See Section 3). Off-label permit approvals are generally restricted to those products that:

- are already registered,
- have existing toxicological and environmental data packages, and
- relevant data on residues and efficacy can be obtained or estimated with some confidence.

Products from the Australian grain industry have an enviable reputation for quality with respect to chemical residues. The National Residue Survey (NRS) provides an active monitoring program for domestic and export grain commodities. Monitoring of commodities for compliance with the MRL (maximum residue levels) indicates whether a product has been used according to an approved label and use pattern.

There are changes in the operating environment of the grain industry which increase the need to cater for minor uses by ensuring there are a wider range of options available. These include:

- a more demanding regulatory environment contributing to concentration by manufacturers and suppliers of agricultural chemicals on fewer chemicals serving larger markets to achieve a return on increasing development costs, and
- a reluctance by manufacturers to fund applied research that would support extension of the coverage of existing generic products to similar uses.

There are remaining substantial differences between States despite ongoing efforts to harmonise the regulatory environment. In Victoria, it is legal to use chemicals (other than specified 'restricted use' chemicals) off-label providing that:

- the maximum label rate is not exceeded,
- the label frequency of application is not exceeded, and
- any specific label statements prohibiting the use are complied with.

Whilst the Victorian system is seen to have advantages by placing greater onus on the user, there are other views that it increases risks of inappropriate use and residue breaches.

Consultation is progressing on implementing a more efficient national framework for more harmonised regulation of agricultural and veterinary chemicals. The consultation included strengthening feedback from stakeholders on priorities and options. Recent GRDC MUP have included monitoring developments in the USA approach to minor use pesticides. Their inter-regional IR-4 project which began in 1963 is a cooperative effort involving state and federal agencies aiming to develop data to facilitate regulatory clearances of newer, reduced risk pest control products for specialty crop growers (Miller, 2007).

A new regulatory pathway, additional to minor use permits, has recently been developed with APVMA to facilitate access for a wider range of uses including major crops. Advisers and growers now have an opportunity to directly influence label recommendations by identifying and suggesting new uses or modifications to existing registrations (GRDC, 2010a). The availability of a wider range of options will be of benefit to farmers, for example, in helping to manage emerging resistance problems or to comply with MRLs.

Gaining regulatory approval has industry benefits by avoiding undesirable consequences, for example prejudicing trade by violation of MRL residue levels in grain, and in grain and crops used for feed for meat and dairy animals. Undesirable consequences are avoided by reducing incentives to use hazardous chemicals not registered for a specific purpose. The consequences include the risks relating to the following six aspects which are part of the information required by APVMA to register a chemical and to satisfy industry and community concerns on their safety:

- Occupational Health and Safety
- Human Toxicology
- Crop Safety
- Environment
- Residues
- Trade

Minor use permits and label extensions are the most readily identifiable outputs of the projects funded. The on-farm impact in this analysis is based on an assessment of the benefits including estimates of the increased profitability from the capacity to use the chemical involved. The increase is from a comparison with a feasible alternative if the minor use permit was not in place.

The major outcomes are then described to estimate impacts from economic, social and environmental perspectives. A cost benefit framework is utilised and supported where possible with non-financial information on impacts. A sensitivity analysis of the assumptions is undertaken, confidence estimates are provided, and the conclusions and lessons learnt are then discussed in the final section of the report.

2. Project Investment

Projects Funded by GRDC

Six completed MUP have been funded by GRDC in this investment cluster as listed in Table 1. The projects were part of the Crop Protection section of the GRDC Output Group 1 – Practices. The GRDC objective for Practices is: "*Better practices developed and adopted faster"*.

Table 1: Details of the Six Projects Funded by GRDC

Project Code and Title	Other Details
JAY1: Grains Chemical Registration Project-1 Pulses	Organisation: Jayanare Pty Limited Period: 1/7/1998 to 31/5/1999 Principal Investigator: Jim Swain
JAY2:Grains Chemical Registration Project – 2 All Grains	Organisation: Jayanare Pty Ltd Period: 1/7/1999 to 30/6/2000 Principal Investigator: Jim Swain
JAY3:Grains Chemical Registration Project – 3 All Grains	Organisation: Jayanare Pty Ltd Period: 1/7/2000 to 30/6/2001 Principal Investigator: Jim Swain
JAY4:Grains Chemical Registration Project – 4 All Grains	Organisation: Jayanare Pty Ltd Period: 1/7/2001 to 30/6/2004 Principal Investigator: Jim Swain
AKC00001: Registration for minor use chemicals for the grains industry	Organisation: AKC Consulting Pty Ltd Period: 1/7/2004 to 30/6/2007 Principal Investigator: Kevin Bodnaruk
AKC00002: Registration for minor use chemicals for the grains industry	Organisation: AKC Consulting Pty Ltd Period: 1/7/2007 to 30/6/2010 Principal Investigator: Kevin Bodnaruk

Table 2 provides a summary of the objectives of each project.

Table 2: Project Codes, Titles and Stated Objectives

Project Code and Title	Stated Objectives
JAY1: Grains Chemical Registration Project- 1 Pulses	• To achieve the registration or have permits issued for priority projects agreed with GRDC.
JAY2:Grains Chemical Registration Project -2 All Grains	• To achieve chemical registration or have permits issued for priority projects for pulses, oilseeds, summer and winter cereals based on consultation with industry and agreed with GRDC, and where outside funding is available for field and residue evaluations.
JAY3:Grains Chemical Registration Project -3 All Grains	• To achieve chemical registration or have permits issued for priority projects for pulses, oilseeds, summer and winter cereals based on consultation with industry and agreed with GRDC, and where outside funding is available for field and residue evaluations.
JAY4:Grains Chemical Registration Project -4 All Grains	• To achieve chemical registration or have permits issued for priority projects for pulses, oilseeds, summer and winter cereals based on consultation with industry and agreed with GRDC, and where outside funding is available for field and residue evaluations.
AKC00001: Registration for minor use chemicals for the grains industry	• To increase the range of needed minor-use pesticides to improve the sustainability of Australian grain production by having the necessary regulatory approvals in place.
AKC00002: Registration for minor use chemicals for the grains industry	• To increase the range of needed minor-use pesticides to improve the sustainability of Australian grain production by having the necessary regulatory approvals in place.

Investment Inputs

Estimates of the total funding by GRDC for the six projects are provided in Table 3. Table 4 shows the total funding over the twelve year period. GRDC contributed 66 percent of the total funding.

Table 3: Investment by GRDC and Partners in the Six Projects (nominal $)

Project	GRDC	Partners	Total
JAY1	43,843	29,500	73,343
JAY2	60,000	40,000	100,000
JAY3	100,000	70,000	170,000
JAY4	366,752	183,376	550,128
AKC00001	372,000	180,000	552,000
AKC00002	345,000	150,000	495,000
Total	**1,287,595**	**652,876**	**1,940,471**

Table 4: Total Investment by GRDC and Partners in the Six Projects for Years Ending June 1999 to June 2010 (nominal $)

Year ending June	GRDC	Partners	Total
1999	43,843	29,500	73,343
2000	60,000	40,000	100,000
2001	100,000	70,000	170,000
2002	116,000	58,000	174,000
2003	134,752	67,376	202,128
2004	116,000	58,000	174,000
2005	126,000	60,000	186,000
2006	123,000	60,000	183,000
2007	123,000	60,000	183,000
2008	115,000	50,000	165,000
2009	115,000	50,000	165,000
2010	115,000	50,000	165,000
Total	**1,287,595**	**652,876**	**1,940,471**

3. Activities and Outputs

Minor use permits, emergency permits and label extensions are the most readily identifiable outputs of each of the projects funded. The outputs are achieved by a wide range of activities including consultation with the grain industry to identify priorities and with chemical companies to identify feasible approaches prior to submissions to APVMA. Field experiments are analysed or organised to provide efficacy data and residue levels and other data that may be needed to obtain approval from APVMA. In many cases, effort is expended in determining whether there is sufficient justification to mount an application. In other cases, efforts to achieve a permit have been unsuccessful. The input from the MUP ranges from minor where another agency has major responsibility to major where MUP supports funding of field trials and has a substantial input. The projects are also involved in a range of communication activities to ensure the grain industry is well informed on opportunities to take advantage of minor use permits and other changes.

A minor or non-major use is defined by regulation (Agricultural and Veterinary Chemicals Code Amendment Regulations 2004 (NO. 3) 2004 NO. 251) and was developed on the basis of the likely economic return to the applicant taking into account the costs to meet registration requirements. A minor use can also be determined on the basis of limited use on a major crop; the guideline for use on a major crop being less than 10 percent of the area nationally or less than 10,000 ha in total. There are 11 crops relevant to GRDC that are deemed "Major" by APVMA guidelines (Commonwealth of Australia 2002). They are barley, maize, oats, sorghum, triticale, wheat, chickpeas, field peas, lupins, canola and sunflowers. (Note that for sunflowers APVMA has recognised the decrease in area may warrant recognition as a minor crop.)

Details of current and expired permits over the period of the MUP are available from the APVMA website (http://www.apvma.gov.au/). Data on over 50 current permits (not all through MUP) relevant to grain producers can also be accessed from the GRDC website. Searches can be by crop, chemical, disease or by State. Some permits cover more than one crop and some are for pastures. Permits are sought by a wide range of organisations and individuals, for example seed companies often directly seek minor use permits for small areas of seed crops for the domestic or international markets for seed. Most of the permits resulting from MUP are held by Pulse Australia on behalf of the pulse industry and the Australian Oilseed Federation (AOF). In addition to permit applications managed by the MUP staff, there are also numerous applications from others where some assistance has been given by MUP staff. Therefore because of the varied nature and extent of the activities undertaken by the projects, the outputs are only listed in general terms in Table 5.

As an illustration, one of the early activities was on a preventative spray to control outbreaks of Botrytis grey mould. Over the period from 1998 to 2004, six minor use permits were issued to Pulse Australia for mancozeb before the registered label was amended to include an additional approved use. The companies involved supported the studies needed to generate additional data, including setting a MRL to achieve registration.

The MUP staff have also had an important role in monitoring related activities internationally and identifying opportunities for local application. The MUP staff involved in the projects have contributed to developments in policy on pesticide use and regulation.

Table 5 Activities and Outputs for the Six Projects

Project Code and Title	Activities and Outputs
JAY1: Grains Chemical Registration Project 1 Pulses	• Identified 8 priority cases to achieve permits or registrations for 11 chemicals to authorise their use in the pulse industry. • Assembled or generated the efficacy and residue data needed to achieve permits or registration. • Registration for 3 pesticides publicised to industry through Pulse Australia.
JAY2:Grains Chemical Registration Project 2 All Grains	• Consulted with the grains industry and the chemical industry to identify priorities for which permits or registrations were to be sought for chemicals not then approved for specified applications. • Listed priorities including assessment of risks of critical levels of residues in grain marketing and of risks to QA programs. • Negotiated with the chemical industry and relevant industry bodies on the conduct of the necessary field and residue evaluations. • Prioritised the list of 79 cases in terms of the likelihood of a permit or registration being achieved within the life of the follow-up JAY3.
JAY3:Grains Chemical	The one year project achieved the following in relation to the initial priority list of 79 cases identified in JAY2 :

Registration Project 3 All Grains	• 14 completed by obtaining a permit or registration. • 26 where a permit or registration was planned to be achieved in JAY3 and where work was in progress. • 9 where some work was done but were abandoned because of lack of acceptable data. • 30 which were planned to be held over to JAY4.
JAY4:Grains Chemical Registration Project 4 All Grains	• Developed priorities based on JAY3 carryover and by consultation with industry for 138 cases for possible advancement towards a permit or registration. • 55 were completed or were work in progress, including 26 for pulse crops and 15 for oilseeds. • 17 cases had permits issued or applied for. • 66 were discontinued; factors contributing to projects being discontinued were assessed and included lack of support by the industry or the registrant, and specific efficacy issues including crop phytotoxicity. • a guide for consultants and researchers was prepared on generating data to support regulatory approvals. • a website was developed and communication undertaken to inform the industry of achievements and to improve understanding of the processes involved.
AKC00001 Registration for minor use chemicals for the grains industry	• Minor use requests for pesticides identified as necessary, collated and processed on behalf of grains industry. • prioritised minor use requests were converted to regulatory approvals (permits and registrations). • extensions were sought for expiring permits where warranted by revised priorities. • Provision of a mechanism to update industry sectors on developments.
AKC00002 Registration for minor use chemicals for the grains industry	• Minor use requests identified by consultation, prioritised and converted to regulatory approvals (permits and registrations). • extensions were sought for expiring permits where warranted by revised priorities. • undertook communication activities and maintained current systems, such as the GRDC website, to update industry sectors on progress. • identified emerging issues for which current management options are unavailable or lack regulatory approvals, for example for new crops or technologies. • developed an alternative regulatory pathway (APVMA Category 25) to achieving label approvals as distinct from permits. • established linkages with minor use research programs in the USA and Canada. • contributed to policy development. • linked with GRDC funded research projects investigating the use of pesticide-based management options to ensure data generated meets regulatory requirements and can be used to gain regulatory approvals.

4. Outcomes

The previous section demonstrated the achievements of the MUP particularly in terms of the key outputs, minor use permits and regulatory approvals.
This section will assess the outcomes resulting from the activities and outputs. The main thrust of the projects has been to fill specific disease management gaps for minor crops and to speed up the approval process for permits. These were typically crops where the areas grown were too small for chemical companies to invest to undertake the product development or the testing required to fill the gap. The projects also included some minor uses in major crops and some emergency uses. The primary outcome of most projects was increased grain production from improved control of pests. Other outcomes will be considered before listing the major direct outcomes for each project.

Overview of Outcomes
The projects had some common outcomes, in particular:

- Reduced disease losses by greater use of chemicals authorised by permits,
- Increased grain production from speeding up and facilitating the availability of chemicals to fill priority gaps, and for use in emergencies in situations where the management options available to grain producers were limited,
- Increased area of pulse crops and more effective rotations with cereal crops,
- Facilitating greater adoption of QA programs by ensuring growers were using chemicals authorised by permits,
- Reducing risks to trade from violating MRL in grain and other products developed from grain and grain crops,
- Reducing risks to human health and the environment by increasing incentives to use appropriate chemicals registered for the specific purpose, and
- Reducing risks of litigation for farmers and advisers by clarifying regulatory approvals.
- Improved design of field trials to ensure efficacy data generated was useful in permit applications.

The outcomes arise from permits for the use of chemicals in accordance with regulations designed to reduce the various risks from the use of hazardous chemicals. There are other outcomes that may be a result of stricter standards applied, for example through QA, by importing countries or by food retailers seeking product that has been grown in ways deemed environmentally sustainable.

MRL compliance – this outcome is assessed through a comprehensive monitoring program on exceedances. As part of the NRS (National Residue Survey), extensive risk-based sampling of chemical–commodity combinations is undertaken to maintain international and domestic market access requirements. If an MRL is exceeded, it usually indicates a misuse of the chemical in terms of the label instructions conveying best practice for example. Exceedance does not normally indicate a public health or safety concern (APVMA 2008b). MRLs are normally set well below the level that would harm health.

For pulses and oilseeds, compliance levels in terms of the Australian Standard were over 97 percent (DAFF 2010a). (For exports, MRL in an importing country may differ from the Australian MRL). For chickpeas, 8 of 44 samples were non-complying. Most were attributed to residues in storages from chemicals registered for other

crops. For the majority of the indicated violations for which there is no MRL any detection above 0.01 mg/kg would register as a violation (Kevin Bodnaruk, pers.comm., 2010).

Rae (2002) summarised a special report on residues in grains from 1995-1999 which showed that organophosphorus insecticides (as a group they are mostly biodegradable and do not concentrate in the food chain) were the most commonly detected residues (in 4-24% of samples of various grains) but that MRLs were exceeded in only about 0.1% of samples. The Australian grains industry has an increasingly effective post harvest chemical usage strategy for control of residues and an enviable record in relation to food safety. In relation to food safety, Rae (2002) reported that the Australian Total Diet Survey consistently demonstrated very low levels of pesticides in Australian diets.

Reducing trade risks – The performance in relation to MRL is achieved by highly effective procedures for registration. The process with the fungicide chlorothalonil widely used for ascochyta control in pulse crops is illustrative. Chlorothalonil has been used in many countries since the 1960s in a variety of applications. MUP was involved with Pulse Australia in securing various temporary permits for ascochyta disease control in chickpeas, faba beans & lentils issued over the period from 1999 before the use appeared on the registered label in 2009. In 2006 APVMA had responded to concerns on potential for residues in meat exports; the current export value is of the order of $6 billion. An initial evaluation of the application was completed in May 2006 indicating further data from animal transfer studies was needed on feeding of pulse fodders and forages.

Risks to human health (non-food related) and the environment - Monitoring of adverse experiences from the use of agricultural products is undertaken by APVMA as a part of its performance reporting. Agriculture and veterinary chemicals are excluded from the Australian Government's regulatory scheme for industrial chemicals (NICNAS, the National Industrial Chemicals Notification and Assessment Scheme). Products that are the subject of minor use permits including those secured through MUP are not specifically monitored other than through adverse experience reporting. APVMA (2010) reported that during the calendar year 2009 the monitoring did not lead to a major regulatory action against any registered product. Under-reporting is considered likely. Some reports warranted actions to mitigate potential risks, including updating product labels.

In relation to health risks, a survey (MacFarlane et al 2008) of Victorian farmers showed that poor use of personal protective equipment indicated possible significant pesticide exposure. Training was seen as an important intervention for reducing farmers' pesticide exposure. In summary the information on risks to human health and the environment is limited and does not provide any information on MUP impacts. The low level of incidents is some indication of low risk. However there may be risks not evident in the short term.

Direct Project Outcomes (on farm)

Although there were six projects, each was in the main a continuation of the work in progress from the previous project and with a common purpose of filling priority gaps. Table 6 summarises outcomes and picks up the main ways the projects evolved over the period. The Table illustrates how each project expanded on the previous projects in their scope and evolved to meet changing circumstances in the regulatory environment. This section then concludes with more detail on outcomes

grouped by examples of the range of situations and the major chemicals involved in the MUP.

Table 6 Outcomes for the Six MUP

Project Code and Title	Outcomes
JAY1: Grains Chemical Registration Project 1 Pulses	• More effective control of pests and diseases in faba beans, chickpeas and lentils following registration of three new chemicals. • more effective control measures of foliar diseases of chickpeas in particular following the severe problems encountered in 1998 with Ascochyta.
JAY2:Grains Chemical Registration Project 2 All Grains	• Increased use of minor use permits extended to grain crops. • more efficient processes for achieving permits or registrations developed by consultation with industry and prioritising 79 cases by likelihood of a permit or registration being achieved. • reduced risks to grain markets of exceeding MRL by including risks in priorities for action.
JAY3:Grains Chemical Registration Project 3 All Grains	• Increased use of more effective chemicals by obtaining 14 permits or registrations for more effective chemicals. • continued work on 26 further priority cases.
JAY4:Grains Chemical Registration Project 4 All Grains	• increased use of more effective chemicals from permits or registrations achieved.
AKC00001 Registration for minor use chemicals for the grains industry	• Increased use of more effective chemicals from permits or registrations achieved.
AKC00002 Registration for minor use chemicals for the grains industry	• Increased use of more effective chemicals from permits or registrations achieved. • increased use of more effective chemicals sought by website and other communication activities to achieve more rapid adoption of information from new permits or registrations. • increased use of more effective chemicals by developing an alternative regulatory pathway (APVMA Category 25) to achieving label approvals for both minor and major uses as distinct from permits

This evaluation includes outcomes from the large number of permits issued as a result of the MUP since 1999. In many cases a series of permits are issued on an annual basis while research proceeds on residue levels and other aspects. For example for mancozeb and chlorothalonil used for disease control in chickpeas, there were 14 permits issued before the fungicides achieved registered label. The 14 permits can be considered as a grouping to make an outcome-based evaluation more feasible.

Groupings of permits considered to account for the majority of likely benefits and to show the range of MUP activities were provided by the leader of the current MUP (Kevin Bodnaruk, pers.comm., 2011). For some diseases a survey (Murray and Brennan, in press) has been undertaken of the value of control (VOC) from pesticides and also from improved varieties and cultural practices, for example from adapting agronomic practices. VOC have been listed where available based on the survey.

The VOC is an average value for the last five years ending 2008/09. The annual VOC for the Australian crop was calculated by deducting estimated average losses from potential losses with no control measures in place. The highest value, an average of $20 million annually was for pesticides for ascochyta disease control in chickpeas, faba beans and lentil.

Twelve groupings are listed below together with VOC data where this was available.

- Ascochyta disease control- Various permits for the fungicide chlorothalonil for chickpeas, faba beans & lentils over the period from 1999 before the registered label in 2009. The VOC is of the order of $20m.
- Botrytis disease control -Various permits over the period 1998 to 2005 for the fungicides mancozeb and carbendazim for chickpeas, faba beans and lentil. Carbendazim is widely used in the south on lentils. Research on residue levels by SARDI during the 1990s was important in facilitating registration by 2005. The VOC is of the order of $10m. There are current concerns on the future use of carbendazim.
- Mice plagues – GRDC trials in the late 1990s contributed to approval of emergency permits for the use of zinc phosphide baiting to replace previous dependence on strychnine.
- Desiccation (mungbeans) - Various permits prior to registration to label over the period 2001 to 2003 for the use of glyphosate, more effective than the alternative which had poor efficacy in relation to post-application regrowth control.
- Etiella moth control – Various permits since 2002 for deltamethrin and esfenvalerate for late season use on lentils in seasons favouring buildup. A short withholding period was required.
- Weed control - Various permits since 2002 for the use of terbutryn to increase options for weed control in field peas in some areas of southern Australia.
- Cercospora disease control - A permit since 2008 for early season control in Faba beans – widely used and achieving a VOC of $0.8m.
- Powdery Mildew control – An Emergency Use Permit for propiconazole for sunflowers was issued in 2008 because of an unusual early buildup and because there was no approved fungicide.
- Desiccation (pulse crops) – reduced yield losses and more effective weed control from a shorter withholding period for Paraquat. Crop topping is widely used on winter pulses in southern Australia. The change was based on a new and recent regulatory innovation through the APVMA whereby chemical companies were notified, following assessment of data generated under the GRDC project AKC00002, that product labels could be amended to accommodate a shorter withholding period.
- Fusarium head blight control - An Emergency Use Permit for Prosaro was issued in 2010 for wheat and barley in anticipation of a buildup in head blight. The permit resulted in effective control of areas of durum wheat on the Liverpool Plains.
- Control of aspergillus crown rot - Following regulatory action to suspend quintozene following detection of dioxin, a permit for Dynasty PD Fungicide as a seed dressing for peanuts was issued in 2010 to allow planting to proceed.
- Diamond back moth control - An Emergency Use Permit was issued in 2010 for an insecticide for use on canola crops on Lower Eyre Peninsula with a requirement to observe the seven-week withholding period between application and harvest.

VOC data for diseases are only available for a few of the groupings. The $20m VOC for ascochyta is clearly the largest and will be the focus in Section 7 on valuing benefits. Overall, the readily identified on-farm outcome from the above groupings is the increased crop production and profitability resulting from the more effective control of various diseases, pest and weed problems. There are some minor use in major crop examples including one for durum wheat. Most are for pulses. None of the examples are specifically for Western Australia which has limited area of pulses apart from lupins, a major crop in that State.

5. Benefits

The most identifiable benefit delivered by the investment has been the increased profitability of grain production. The conclusion of Crowe et al (2007) should apply. A case study assumed regional research to speed up adoption by developing a regional approach to using a new herbicide in chickpea production. Their conclusion was: "*grain growers not only collectively fund much of the cost of herbicide use R&D, but also capture most of the benefits*". The main constraint on the capacity of agrichemical companies appropriating benefits arises from the existence of competitive products compared to the situation with patented biotechnological innovations.

Rose and Shepherd (2010) in a submission to a DAFF discussion paper listed the following public benefits from an effective minor use program:

- Improving storage or shelf life for food products,
- Meeting consumer expectations for safe residue-free food, noting in 2008/09 the majority of MRL established in Australia arose from minor use permits, highlighting the demand for minor uses,
- Contributing to protection of the environment,
- Managing Australia's international reputation for food production,
- Reducing impediments to free trade, and
- Flow on effects to other industries such as the use in fodder and grain products for livestock and dairy product industries.

However, the Productivity Commission (2008) did not consider that from an equity perspective the outcomes of control-of-use regimes should be perceived as a public benefit. Their basis was that the regulatory regimes are in place to manage the adverse impacts of the use of pesticides. Therefore their outcomes are more appropriately described as a reduction in the negative externalities or spillovers resulting from use of pesticides.

The Productivity Commission in reporting on health, safety, and environmental impacts of agricultural chemicals concluded that regulation should focus more on community benefits by more explicit consideration of risk. Issues raised included the cumulative risks of multiple chemicals. Overall for chemical use generally it was concluded that current approaches were *"broadly effective in managing risks to health and safety, but are less effective in managing risks to the environment".* In response to various reviews of aspects of pesticide regulation and use, submissions were called addressing a discussion paper released in late 2010 (DAFF 2010b). The paper included aspects relating to protection of human health and the environment, and alignment of regulatory effort with the degree of risk. For example, registration

costs could be more reflective of the risk of the potential externalities involved in the use of a pesticide.

The review by AATSE (2002) had concluded that the limited information on impacts of pesticides on the environment warranted a "*comprehensive integrated national environmental monitoring program"* which included post-registration monitoring.

The general implication from various reviews is that there may be more efficient and effective ways to achieve an optimum level of regulation of pesticide use, ways that would increase the benefits to the community and to growers of crops requiring minor use pesticides. Concerns in an independent review (ACIL Tasman (2008) prepared for the Animal Health Alliance and CropLife Australia) have included the perverse incentives involved in the APVMA cost recovery process including lack of alignment with externality risks and the need for APVMA involvement in efficacy testing for all products. Earlier in the decade, Chisholm (2002) raised the possibility of "crowding out" whereby public investment in issuing off-label permits would in some cases obviate a firm from incurring additional costs to secure registration of additional minor uses. The other view evident for some permits secured by the MUP is that the MUP enabled the market to grow to a size where it was economic to pursue registration. But that view assumes the chemical company did not foresee the growth.

There is in summary very limited information on benefits additional to on-farm increases in profitability from increased availability of pesticides. A qualitative summary of the benefits from bringing pesticides under more effective control of use through permits follows. In each case the positive benefit could be expected to be reduced to some extent by the increased use of pesticides given they are more attractive as a result of having a permit system.

- Food safety – increased consumer confidence and risk of MRL exceedances decreased from greater uptake of QA and compliance with labels,
- Occupational Health – reduced risks from greater uptake of QA,
- Environment - increased use of pesticides in accordance with agricultural best practice as per registered labels would reduce risks to the environment,
- Sustainable production – increased capacity to demonstrate to consumers that food products are from sustainable systems using QA for example, or from increased availability of more selective pesticides of value in developing IPM, and
- Trade – substantially reduced risk and perception of risk because of the increasing proportion of production grown using registered products and adopting QA.

Overview of Benefits

An overview of benefits in a triple bottom line categorisation is shown in Table 7.

Table 7: Categories of Notable Benefits from the Cluster Investment

Benefit	Levy paying industry and its supply chain	Spillovers		
		Other industries	Public	Foreign
Economic	• Increased profitability and reduced risk from	Reduced risk of MRL exceedance in	Improved industry input into	Reduced trade risk of MRL exceedance in

	increased availability of more effective registered chemicals. • Continued maintenance of grain markets.	industries based on grain industry products.	government rural policy on chemical use.	grain imports.
Environmental	More sustainable cropping from increase in pulses and in Quality Assurance.		Improved stewardship.	
Social	Reduced human health risk from chemicals.		Australian consumers receive safer grain products.	Foreign consumers receive safer grain products.

Public versus Private Benefits
The benefits identified from the investment are predominantly private benefits, namely benefits to grain producers and to a lesser extent to their supply chains.

Benefits to other Primary Industries
Benefits to other industries, particularly meat and dairy, are likely to be substantial. MRL exceedances from residues from grazing of crop stubbles, and feeding grain products have been a major risk factor for meat industries.

Distribution of Benefits along the Grains Supply Chain
Most benefits accrue to grain producers and to a lesser extent their supply chains, particularly input suppliers including chemical companies, and advisers to grain producers.

Benefits Overseas
It is unlikely that any of the outputs produced by this investment will significantly benefit overseas grain industries. There is however a substantial degree of international cooperation on some aspects such as MRL. There are benefits to overseas importers and consumers of Australian grain and products based on the grain industry from reduced risk of MRL exceedances.

Match with National Priorities
The Australian Government's national and rural R&D priorities are reproduced in Table 8.

Table 8: National and Rural R&D Research Priorities 2007-08

Australian Government	
National Research Priorities	**Rural Research Priorities**
1. An environmentally sustainable Australia 2. Promoting and maintaining good health	1. Productivity and adding value 2. Supply chain and markets 3. Natural resource management 4. Climate variability and climate

3. Frontier technologies for building and transforming Australian industries 4. Safeguarding Australia	change 5. Biosecurity *Supporting the priorities:* 1. Innovation skills 2. Technology

Table 9 identifies the relative importance of the rural research priorities addressed by the cluster as a whole.

Table 9: Categorisation of Benefits by Priorities

Benefit	**Research Priorities Addressed**	
	National	**Rural**
• Increased industry profitability • Increased farm profits • Maintenance of grain markets		• Priority 1*** • Priority 2***
<u>Reduced chemical risk</u> • environment • human health • food safety	• Priority 1* • Priority 2* • Priority 2*	• Priority 3* • Priority 2* • Priority 2*

*** Strong contribution **Some contribution * Marginal contribution

Additionality and Marginality

The investment in this cluster was targeted principally towards benefits to grain producers and others in the grain supply chain involved with marketing. As grain complying with MRL is a key component of the high quality image of Australian grain (both domestically and internationally), these projects would have been regarded as a high priority by levy payers. The projects were relatively low cost, of the order of $100,000 annually. In the event that the government matching contribution to GRDC was restricted and assuming a levy system was still in place, it is likely that eventually many of the high priority projects would have still been funded by other agencies, by industry, or been avoided to some extent by changes to processes for registering chemicals. There would have been a lag involved. (Note this evaluation has assumed that after more than a decade the Without MUP Scenario would have eventually achieved the same outcomes as the With MUP Scenario.)

If no public funding at all had been available for GRDC, it is estimated that the investment would have been limited to about 90 percent of the investment actually recorded but with a lag. A summary of the potential response to reduced public funding is provided in Table 10.

Table 10: Potential Response to Reduced Public Funding to GRDC

1. What priority were the projects in this cluster when funded?	High priority for GRDC and industry

2. Would the investments still have been made in this cluster if 50% less public funds were available to GRDC?	Yes
3. Would industry and others have funded this cluster if no public funds were available to GRDC?	Yes but with a lag, to the extent of about 90% of that actually funded

6. Pathway to Adoption

The MUP have features that distinguish them from other delivery channels contributing to extension and adoption. A key one is the degree of industry involvement from needs identification through to the responsibilities of the holder of the Minor Use Permit. For the MUP a permit holder was typically a grower association or peak grower body, particularly Pulse Australia and the Australian Oilseeds Federation. The permit holder assists in preparing the submission for a permit and in ensuring members are aware of current permits. Most of the widely used permits were issued to Pulse Australia and involved the Industry Development Manager (Northern Region). The GRDC also actively promotes current permits through its websites and through links to the APVMA website. Important developments such as the registration achieved for carbendazim following several years as a minor use permit are also publicised in Ground Cover (GRDC 2005).

It can be assumed that growers who routinely use pesticides would actively seek out information on new permits and registered products. The information is promoted through a wide range of extension products by industry, for example Variety Management Packages developed by Pulse Australia, State Department sowing guides, and by seed company promotions. However no data was available on awareness and use of new permits.

7. Measurement of Benefits

Benefits from the investment in the MUP are measured against the alternative – the evolving baseline provided by a "Without MUP investment" scenario. If the options for pest and disease control were limited by the range of available pesticides, there would have been a range of impacts including reduced yields resulting in some cases in alternative crops being grown. The scope of this evaluation includes benefits from the large number of permits issued as a result of the MUP since 1999.

The benefits where it is feasible to make some quantitative assessment are:

- the increased profitability from reduced disease losses from crops which were the subject of permits, and
- the increased area of crops which were the subject of permits as a result of their increased profitability compared with the crop displaced.

Other evaluations of benefits – Miller (2007) in an evaluation of the IR-4 project in the USA refers to a number of constraints in measuring benefits from pesticide use for the 10,000 pest control clearances achieved by IR-4. The IR-4 evaluation is widely quoted. Less well quoted are the serious reservations as raised for example by the Productivity Commission (2008). The lack of consideration of the Without Scenario and of attribution of benefits to other investments are examples. The inherent complexity of IR-4 was avoided by using an aggregate input-output analysis and by using a meta-approach that averages productivity changes across

commodities and across estimates by various researchers using diverse techniques. For example, a return of $2.50/$ of expenditure on pesticides was indicated as was a reduction in industry output of 11.4 percent assuming no-pesticide application. Overall the IR-4 project was shown to have a contribution of several billion dollars to the USA economy from the $15 million expenditure.

Two Australian examples of benefits in relation to pesticide activities follow. AATSE (2002) referred to a 1998 study by the South Australian Government on favourable returns from government intervention in pesticide regulation. For New South Wales, an evaluation of maintaining the existing degree of regulation, indicated there were likely to be significant benefits from increased training and from notification of pesticide use (DECC, 2009).

The scope of this assessment

Section 4 discussed the scope of the outcomes in terms of the number of permits and for 10 groupings of permits addressing a specific disease or other concern. The 10 groupings included over 50 individual permits each of which could potentially warrant a separate evaluation of benefits and costs, well beyond the scope of this analysis.

The grouping for ascochyta in the three pulse crops, chickpeas, faba beans and lentils had the largest VOC. The grouping is therefore a logical and feasible one for concentrating on initially to value benefits. Based on a very simple extrapolation using GRDC levy and value of production data for 2008/09, the benefits for the three pulse crops would need to be scaled up by a factor of 50 percent to provide an approximation of the benefits for the crops involved in the MUP. The main additional crops include soybeans, peanuts and mungbeans.

Control of ascochyta using fungicides which were the subject of permits generated by the projects could be expected to provide some minimum assessment of the benefits from MUP. The control chemicals, mancozeb and chlorothalonil were the subject of 14 temporary minor use permits over the period from 1998 to 2009 before they reached registered label status in 2004 and 2009 respectively. There are complex technical judgements involved in developing a Without Scenario. The one developed for ascochyta might be considered as at least illustrative of the major theme of the Without Scenario, and also generally applicable to other groupings of permits. The theme is there would have been drivers that eventually ensured the chemicals needed became available at least for the most profitable applications. The three drivers would have been:

1. growers wanting to grow more profitable crops with more effective chemicals,
2. marketers wanting grain that complied with MRL, and
3. a global community increasingly concerned with chemical use, food safety and the environment, and often informed by selective, even alarmist, media coverage.

<u>The production basis for the ascochyta example</u> - The recent average production achieved by the three major pulse crops is shown in Table 11. The actual and potential losses from ascochyta are also shown together with estimates of the VOC attributable to fungicides.

Most faba beans and lentils are grown in the Southern Region. Chickpeas have been increasingly grown in the Northern Region following the devastating losses from ascochyta in Victoria, particularly in 1998. In northern New South Wales, the area of

chickpeas has grown at a rapid rate over the last decade, of the order of averaging an annual increase of 15 percent (estimated from NSW Industry and Investment 2011 data). The growth rate has been achieved despite major droughts and some extreme disease years. The pulse industry in the Southern Region had grown rapidly during the generally good seasons around mid-1990s as had canola. The potential contribution as break crops for weed and disease control in a no-till rotation has been quickly recognised and realised over the last two decades. To simplify the evaluation and recognising some substitution between pulse crops, the evaluation will be done for the three major pulse crops in eastern Australia combined. Chickpeas is the major crop accounting for over half the total, with the major current share of that in northern NSW. Chickpea data will therefore be relied on to inform judgements on the key benefits.

Table 11: Average Annual Production Areas and Values, Losses from Ascochyta Disease, and Value of Control Estimates for Chickpeas, Faba Beans and Lentils for the Five Years ending 2008-09 (estimated from, or from Murray and Brennan, in press)

Item	Chickpeas			Australia		
	Northern Region	Southern Region	Australia*	Faba beans	Lentils	Total (3 crops)
Area (,000 ha)	220	76	300	140	120	560
GVP $m	109	39	151	42	62	254
GVP/ha	495	513	504	294	516	454
Ascochyta Losses Potential/ha	104	209	134	67	133	116
Actual/ha	16	15	16	8	7	12
Value of Control VOC/ha	88	194	118	59	125	105
VOC (Pesticides)/ha	39	58	41	18	50	36
Fungicides /ha	38	81	49	55	114	64

*Includes data for some small areas in Western Australia

Potential losses from ascochyta are particularly high for chickpeas in the Southern Region and for lentils. Table 11 shows the contribution that fungicides make to the VOC. Breeding and cultural measures also contribute at similar levels. The VOC (Pesticides) of $36/ha for the three pulses is primarily the control achieved by fungicides at an indicated (and seemingly unprofitable and therefore incongruous) control cost of $64/ha. Discussion with an author (John Brennan, pers.comm, 2011) indicated that the fungicide costs were from small samples and also that there are likely to be substantial interactions between the three control measures. The latter case would suggest that the data could not be used to estimate a yield loss for the extreme situation if no fungicide was applied. Clearly in extreme cases there would be total crop loss in some years. A further explanation is that some fungicides are applied during crop growth in relation to changing disease expectations so that sunk costs on previous applications are not relevant. The conclusion for this evaluation is that the Table 11 data can only be used for a general indication of the value of fungicides and the potential for extreme loss if they were not available.

The Without Scenario

The key assumption shaping what is a hypothetical scenario is a restrictive one of no investment by GRDC in the MUP from 1998 to 2010. (Recall the logic is that an evaluation can only be done by comparing the outcome with an investment against the outcome in the absence of the investment). Therefore the industries that did benefit from the MUP would, at least initially simply have continued on the trajectory they were on in 1998. The Without Scenario will therefore need to define a trajectory over the period from 1998 to 2010 taking into account trends and drivers in the industry operating environment over that period including community pressures.

The following clarifies the basis for estimating benefits. The Without Scenario in this section is defined in relation to the actual. There will be discussion for example of increased disease losses in relation to actual losses incurred. However when benefits are defined, losses will be reversed in sign and discussed in terms of losses avoided as the benefit.

The project proposal (GRDC 1998) for the first MUP, JAY1, defines relevant aspects of the base-line situation in 1998. Pulse Australia had been funded by GRDC in 1996 to review 'off-label' use of pesticides in the pulse industry. The pulse industry was emerging as a major player on world markets which were increasingly concerned with residue levels. The review indicated that:
"farmers producing pulse crops did not have access to a wide range of registered pesticides, and as a consequence were forced to use unregistered pesticides if they are to maintain profitable and sustainable production. This has implications for the quality assurance programs being promoted by the pulse industry In addition the authorities responsible for the sale of pesticides in Victoria had threatened legal action against pulse growers who have used unregistered pesticides on their crops."

The Pulse Australia review raised three trends relevant to the Without Scenario:

1. the increasing dependence on unregistered chemicals,
2. the implications for QA programs, and
3. the legal implications from using unregistered chemicals.

Note unregistered chemicals include chemicals which may be registered for similar situations or similar crops but the intended use is not specifically provided for on the product label. Minor use permits authorise specific off-label uses. In the following, the term "unregistered" will include the absence of a minor use permit as well unless specifically mentioned otherwise.

The AATSE (2002) review of pesticides noted the 40 percent increase in pesticide increase for all crops from 1996 to 1999, and earlier dramatic examples of residue detections on export markets. Industry and community concerns were becoming major drivers of change in the range of regulatory measures used for pesticide control. The AATSE review of off-label use quoted a submission observing that "as-of-right" use as in Victoria "*placed growers in Victoria in the unenviable position of needing to second guess complex matters."* On the other hand, the permits legalise what would have been illegal under the varying legislative requirements of the States. Also quoted was an NFF submission commenting that on the basis that they considered that the permit system at that time had a reduced risk assessment compared with registration, therefore *"the potential for environmental damage and untenable residue in produce is increased."* Following a number of studies of national pesticide issues APVMA (2003) summarised as follows:

"*The following structural shortcomings have been identified as coming between the current and future ideal system:*

- *varying approaches to control of use between States / Portfolios,*
- *lack of overall policy integration, formal links and interfaces, and*
- *fragmented and limited monitoring of outcomes."*

The implications discussed above would have been increasingly expressed as major potential threats to the viability of the industry if there was no MUP investment. The pulse industry was increasingly being recognised as an essential component of a sustainable grain industry. Alternatives to the MUP would have eventually been found. Drivers could have been policy changes relating to the requirements for registration of chemicals, making greater use of international data, or for protection of additional data generated by companies. There would for example have been increasing incentives for grower groups to take out permits themselves or for chemical companies to take action if they were not able to market through a permit system. The latter situation would depend on a company recognising eventually that the market was mainly constrained by the availability of a key chemical. (It is recognised that the permit system can also enable an industry to develop to a size where it is attractive to a chemical company). It will be assumed following discussion of the major trends likely for the Without Scenario, that the pulse industry would have continued to develop, but at a lesser rate and with increased disease losses. It is unlikely alternative approaches would have been as effective as permits achieved by the MUP.

Research and extension implications - The increasing dependence on unregistered chemicals would have had negative implications for the direction of research and extension programs aiming at promoting the pulse industry. GRDC was giving increasing priority to pulse productivity but it would have been difficult to promote crops dependent on unregistered chemicals. In 1996 the Australian Coordinated Chickpea Improvement Program was developed to consolidate activities. In 1999-2000 for example GRDC invested $8.5 million in a pulse productivity program including projects in breeding and management to reduce ascochyta impacts (GRDC 2000). New varieties were being developed that needed reduced numbers of fungicide sprays. Pulse Australia was promoting Variety Management Packages (VMP) which brought together a wide range of information including disease management using fungicides. However, many growers would presumably have continued to ignore advice to ensure that only registered chemicals be used. There is no information which would identify the change in chemical use resulting from MUPs. As the JAY1 Final report to GRDC stated: "*We are not able to undertake a Benefit Cost Analysis resulting from the project because of the lack of available data on usage and adoption. In many cases the pesticides were already being used without formal approval."*

QA aspects – human health, environmental and food safety issues have become of increasing concern to the grain industry and to the community generally. The capacity to detect even extremely low levels of chemicals has increased. Stringer and Anderson (2000) in an international review considered that Australian agriculture had been largely insulated from environmental and government concerns. The following comment in the GRDC 1999-2000 annual report would not be made currently. "*Food safety appears to be a minor concern to the grains industry, but it is a vital concern to consumers..."* The statement was in the context of toxin-free varieties of peanuts; but it serves to illustrate that attitudes have changed. A comprehensive survey (Williams et al 2004) showed that over one half of Australian adults were

more concerned about food safety than they were in 1999. Chemical residues were a major and increasing concern.

QA was becoming an important component of supply chain strategies for an industry to promote its image as a marketer of chemical-free grain. Breaches in canola consignments to Japan in 2006 stimulated action on QA including for example Better Farm IQ in Western Australia (Norwood 2010).The disconnect between the risks and the reactions of consumers had increased. Although the grain industry had an excellent record as judged for example by MRL compliance, any incidents tied to the use of unregistered chemicals would have been potentially damaging to the grain industry generally.

Legal implications – pulse growers were increasingly recognising their responsibilities in relation to pesticide decisions. Declarations to grain marketers on chemical products used were a factor. Further over the last decade there has been an increase in the use of advisers for agronomic decisions. The recent survey (IPSOS-Eureka 2010) for GRDC showed that close to half of growers used paid advisers. They would have been unlikely through duty of care liability to advise on use of unregistered chemicals. A fact sheet (GRDC, 2010b) on late season herbicide use has clear warnings on the responsibilities of growers and advisers to avoid chemical residues.

At the farm level, two trends are considered likely to have emerged after 1998 if there was no MUP:

- Increasing grower concerns resulting in some reduction in the use of unregistered fungicides leading to an increase in disease losses, and
- Reduced area of pulse crops as a consequence of their reduced profitability.

Increased disease losses (the without MUP scenario) – from 1998 until the drought year of 2002 the area of chickpeas was expanding rapidly in the Northern Region. New growers would have been inexperienced in ascochyta management. Moore and Knights (2009) reported that disease incidence in 2008 was the highest since the La Niña of 1998 and that losses were increased by grower complacency. The above average rainfalls in the extreme La Niña year of 2010 also contributed to major disease losses. There was a severe shortage of fungicides and emergency permits were sought by Pulse Australia to use unregistered products.

The Murray and Brennan survey over the five years to 2009 reported that 26 percent of the Northern Region was not treated by fungicide. There is considerable scope to reduce disease impacts by agronomic measures including seed treatment and using paddocks away from sources of soil and air-borne inoculum. Overall it can be concluded that for the first few years of the last decade, there would have been increasing disease losses without the MUP compared with what did eventuate. The increase would have been determined by some reduction in the use of unregistered fungicides and only partial success of increased attention to agronomic measures. The scope for greater attention to agronomic measures was still being promoted in 2011 following the major losses due to disease in 2010. As Moore et al (2011) stated following an increase in density and cropping intensity of chickpeas in a wheat rotation "*However, careful selection of seed source, paddocks and varieties, combined with seed dressing and foliar fungicides, will help you manage these diseases in 2011*."

There are three factors suggesting there would have been a slowing down in the extent of disease losses by the middle of the last decade:

1. the increasing availability of varieties with increased resistance requiring fewer fungicide applications. If only mancozeb is considered, Table 12 demonstrates the superiority of the desi varieties Yorker and Flipper over the earlier released and still widely grown Jimbour. (Genesis425 is a Kabuli variety not widely grown in the Northern Region.
2. the increased degree of adaptation that would have happened, for example increased attention by researchers and farmers on agronomic measures.
3. there may have been scope for some chemicals to achieve either registration or temporary permit status by the activities of various agencies including grower groups.

Fuhlbohm and Moore (2004) reported that in 2003 about one quarter of the northern area had reduced yield due to ascochyta. Timely applications of mancozeb were effective in that season as a preventive often applied on a rain forecast. Research at Tamworth (Table 12) had shown that chlorothalonil was generally a superior treatment particularly for the earlier released variety Jimbour. However if only mancozeb was available it would have been a competitive treatment applied on Yorker and Flipper, varieties released by the NSW DPI in 2005.

Table 12: Gross Margin ($/ha) results from Tamworth fungicides trial (Scott 2009)

Variety	**Year Released**	**Fungicide Treatment**			
		Chlorothalonil	**Mancozeb**	**VMP***	**Nil**
Jimbour	2001	502	197	437	- 393
Yorker	2005	477	448	512	149
Flipper	2005	435	413	416	339
PBA HatTrick	2009	374	380	546	427
Kyabra	2005	437	129	438	423
Genesis425	2009	534	625	618	482

*Variety Management Package

Comments from two Pulse Development Officers (Wayne Hawthorne and Gordon Cummings, pers. comm., 2011) emphasise that mancozeb and chlorothalonil were essential for disease control in pulse crops. To illustrate that the situation is not static, both fungicides are currently in the APVMA Priority 2 category nominated for review because of environmental, human health and residues concerns. Mancozeb is more useful in the Northern Region. Without fungicides it was estimated that the northern industry would have been limited to 100,000 ha and based on less well adapted Yorker and Flipper varieties (Gordon Cummings, pers. comm., 2011). In the Southern Region, more resistant faba bean and lentil varieties were becoming available but fungicides were still essential particularly in wet springs.

By the middle of the last decade it is likely that pressure would have been building to find alternative ways of making registered fungicides available. The pressures would have arisen from concerned marketers, from the community if there were MRL exceedances, and from growers who were increasingly recognising the benefits of pulse crops as a break crop for disease and weed control.

Mancozeb had minor use permits until registered in 2004 following residue studies. The path to registration was longer and more expensive for chlorothalonil.

Chlorothalonil has been used on a range of crops in many countries since the late 1960's. APVMA consulted on registration in 2006. Further data was sought to address the risk to trade in animal commodities including edible offal, resulting from feeding of pulse forages and fodders. Lengthy and expensive animal transfer studies were necessary to determine Export Slaughter Intervals before registration was achieved in 2009.

The above can be summarised as follows for the Without Scenario:

- disease losses would have increased for the first few years of the decade as growers reduced use of unregistered fungicides and relied more on agronomic measures,
- some growers used to cereal production using registered pesticides would have been less inclined to adopt some more risky pulse crops in rotations,
- by mid-decade the trend could have reversed as more resistant pulse varieties became available and alternative means of registration or permits were being achieved for some chemicals, and
- during the period of increasing disease losses, there would have been some reduction in areas of pulses as other crops became more profitable and less risky.

There is little data to inform judgements on the increase in disease losses from growers reducing use of unregistered fungicides. If average losses and the risk of extreme losses are large enough growers will switch to alternative crops. Table 11 shows that losses with current VOC are $12/ha and potential losses are $116/ha. The reduction in gross margin chosen for the maximum level is set at a further $12/ha. The increased disease loss per ha is assume to increase from zero in 2000 to the maximum in 2004 and then decline to zero by 2010.

Reduced area of pulse crops (the Without MUP scenario) – the increased disease loss would contribute to a reduced area of pulses and increased areas of alternative crops depending on their profitability compared with areas of less profitable pulses. A peak reduction of 15 percent in 2004 is assumed and then a decline to zero by 2013.

Reduced profitability from reduced area of pulse crops (the Without MUP scenario) – Because of increased disease losses, some growers would switch from pulse crops to alternative crops. Depending on the crop chosen, there would be a loss from both the current year gross margin and from the break crop benefit to the following crop. The break crop benefit can be from disease control, a weed break or from additional soil moisture.

Some judgements are necessary to arrive at an estimate of possible benefits over the last decade. The most important trends for Northern NSW using area data from NSW Industry and Investment (2011) were:

- increased adoption of options for disease control in chickpeas based on fungicides, new varieties and cultural measures,
- price trends particularly the doubling of chickpea prices around 2006 and 2007 and the increased wheat prices in 2007 and 2008,
- recognition of the value of chickpeas in the cereal-based rotation, now accounting for over half of other winter crops apart from wheat and barley, and
- recognition of the value of canola, the area increasing to average close to half the chickpea area over the last two seasons.

There is a limit to the area of chickpeas given that more than one crop in four years in a rotation with wheat increases disease risk. In Northern NSW the proportion has increased to one sixth in recent years.

In the GRDC Northern Region, there are a range of crops that could have increased in area if chickpeas were less profitable because of increased disease losses. Preference would have been for a crop that had value in the rotation given the increasing disease problems of continuous cereals (GRDC 2011). Gross margins for alternative crops are listed in Table 13 for two years to provide some coverage across the decade. Gross margins are prior to planting so they are more relevant to planting intentions than to profitability outcomes.

Table 13: Gross Margins Estimates for Northern New South Wales Cropping Options in 2003 and 2010.

Alternative Crops	Northern NSW Gross Margins* ($/ha)	
	2003	2010
Wheat	190	116
Malting Barley	248	163
Wheat (after Chickpeas)	274	226
Wheat (after Canola)	258	193
Chickpeas	265	109
Canola	259	173
Safflower	197 (east)	293 (east)
Sorghum	236	297

*The gross margins are an average of North eastern and North western NSW provided by Fiona Scott, NSW Industry and Investment, Tamworth.

A fact sheet on rotations in the Northern region demonstrated the value of chickpeas in a cereal rotation in terms of control of crown rot, nitrogen and subsequent wheat yields. Canola and sorghum were also shown to be useful alternatives (GRDC 2011). Wylie (2008) showed that for Queensland, sorghum was superior to wheat in cooler areas and would expand in area with increasing demand. The Without Scenario has to be defined in relation to those trends and also taking into account the consequences if the prospects for chickpeas were less attractive because of limited disease control options. Research priorities would have changed and farmers would have adapted. For example canola is now seen as a promising prospect in more favoured northern areas as is safflower.

From Table 13, the value of Wheat (after Chickpeas) compared with Continuous Wheat is $63/ha.; little different to Wheat (after Canola) compared with Continuous Wheat. So for the Without Scenario given that chickpeas would have been a less attractive option, the reduced gross margin could range from around zero for an alternative break crop like canola to over $60 if continuous wheat was the alternative. There are of course many other feasible alternatives that could be considered as a typical one. But a good starting point is recognising that the chickpea area has grown rapidly over the last decade and is therefore clearly more profitable than alternatives. The analysis will therefore assume an initial benefit of $60/ha, decreasing by 2014 to $30/ha, about average of the comparisons with a canola rotation and with continuous wheat.

Adoption
The main assumptions relating to adoption are the increased area of pulse crops from reduced disease losses and being able to use registered pesticides. Pulse crops are generally highly responsive to changing profitability. The increase of 15 percent over four years is feasible. In northern New South Wales the area of chickpeas trebled from 2003/05 to 2007/09 in response to a doubling of prices. Given all the uncertainties around the magnitude and the timing of the benefits, the evaluation will include sensitivity analysis of the adoption assumptions.

Scaling up
The estimate of the scaling up factor to account for benefits to other crops in the MUP was 50 percent based on the value of production of other minor crops apart from the three pulse crops. The main other crops were oilseeds which were the subject of some permits as shown in previous sections. Ideally, scaling up should attempt to account for the timing of the costs and benefits of numerous permits or groupings of permits over the period from 1998 to 2010.

The ascochyta example was selected because it was likely to be one with the largest benefits. There are other factors that would need to be considered; permits in the early years may have been those with the largest benefits. But the demand for new permits is far from static as community pressures and the availability of chemicals change, and as pest problems evolve or change with the seasons.

Attribution
The extent to which the benefits can also be attributed in part to investments by others needs to be taken into account. Some of the major investments, for example by GRDC, Pulse Australia and State Government R&D agencies in promoting pulses would still have been made. But they would not have been as effective because fungicide use was an integral part of the VMP package. Other investments such as development costs incurred by chemical companies are assumed accounted for by future company profits. Overall an attribution of one third of the benefits that have been assessed is assumed for the investment in MUP

Benefits not Valued
As discussed in Section 5, the benefits not measured were reducing risks relating to food safety, occupational health, the environment, sustainable production and trade. Of these, the benefits from MUP are likely to be the most significant for trade by consolidating the reputation of Australia for safe products grown under systems that minimise risks from chemicals. A more comprehensive evaluation would also consider other costs and transfer payments. There are costs involved in permit applications but APVMA is effectively self-funding so the costs are off-set by costs to chemical companies.

Summary of Assumptions
A summary of the key assumptions made is shown in Table 14.

Table 14: Summary of Assumptions for Financial Years ending June 1999-2013

Item	Assumption	Source (Author Estimates if no Source)
Benefit basis	Increased profitability (compared with the Without Scenario) of production for three major pulse crops (chickpeas, faba beans, lentils) resulting from availability of permits for fungicides for ascochyta control (based on the concentration of MUP on pulses and their high VOC (Murray and Brennan, in press)	
First year of Benefit	2001	Lag from start of MUP in 1999.
Final Year of Benefit	2013	The year when increased profitability (compared with the Without Scenario) was assumed to be zero.
Total Area of chickpeas, faba beans and lentils	530,000 ha (constant total area)	Estimates including from Table 11 of the average for the three pulse crops from 2001 to 2013.
Pulse Crop Losses Avoided (disease losses avoided in a minimum of 85% of actual pulse area)		
Pulse area applicable • Increased area due to investment • Year of maximum increase • Trend	• 15 % increase in pulse crop area • 2004 • Increasing from zero in 2000 to 15% in 2004 • Decreasing to zero by 2013	Assumes, within the fixed total area of pulse crops of 530,000 ha, that a minimum of only 85% would still have been planted without the investment and therefore would have avoided the disease losses with the investment; the 85% minimum would have increased to 100% by 2013.
• Disease losses avoided in pulse crop	• $12/ha in 2004 declining to zero in 2013	Applies to applicable area of 85% to 100% of actual pulse area. These losses avoided have been assumed equal to the current losses with fungicide control (Murray and Brennan, in press).
Alternative Crop Displaced (benefit from increased gross margin from pulse crop)		
Increased profitability • Area impacted • Increased gross margin	• 0-15% of the area of pulse crops (Maximum of 15% in 2004) • $60 per ha in 2001 reducing to $30 by 2013	Assumes a maximum of 15% increased area of pulse crops as alternatives become less profitable. Gross margins were derived from Table 13 (gross margins for a range of northern NSW grain crops from Fiona Scott, NSW Industry and Investment, Tamworth).
Scaling Up Factor	50%	Additional benefits based on the relative value of production of the other crops in the MUP.
Attribution of Benefits to MUP	33%	Based on contributions from other agencies.

Results

All past costs and benefits were expressed in 2010/11 dollar terms using the CPI. All benefits after 2010/11 were expressed in 2010/11 dollar terms. All costs and benefits were discounted to 2010/11 using a discount rate of 5%. The base run used the best estimates of each variable, notwithstanding a high level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment to the final year of benefits assumed.

Investment criteria were estimated for both total investment and for the GRDC investment alone. Each set of investment criteria were estimated for different periods of benefits. The investment criteria were all highly positive as reported in Tables 15 and 16. A feature of the analysis is the rapid early increase in benefits reflecting the rapid adoption achieved in the early years of the investment.

Table 15: Investment Criteria for the Total Investment and Total Benefits for Each Benefit Period from 2009/10 (discount rate 5%)

Criterion	Years from 2009/10						
	0	5	10	15	20	25	30
Present value of benefits (m$)	39.7	42.2	42.2	42.2	42.2	42.2	42.2
Present value of costs (m$)	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Net present value (m$)	36.5	39.0	39.0	39.0	39.0	39.0	39.0
Benefit cost ratio	12.4	13.1	13.1	13.1	13.1	13.1	13.1
Internal rate of return* (%)	na	na	na	na	na	na	na

Note: * The internal rate of return was not calculable because of the time pattern and magnitude of benefits in relation to costs

Table 16: Investment Criteria for the GRDC Investment and Benefits to GRDC for Each Benefit Period from 2009/10 (discount rate 5%)

Criterion	Years from 2009/10						
	0	5	10	15	20	25	30
Present value of benefits (m$)	26.2	27.9	27.9	27.9	27.9	27.9	27.9
Present value of costs (m$)	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Net present value (m$)	24.1	25.8	25.8	25.8	25.8	25.8	25.8
Benefit cost ratio	12.4	13.2	13.2	13.2	13.2	13.2	13.2
Internal rate of return* (%)	na	na	na	na	na	na	na

Note: * An internal rate of return was not available because it was not calculable because of the time pattern and magnitude of benefits in relation to costs.

The annual cash flows of undiscounted benefits are shown in Figure 1. The pattern reflects the assumptions made particularly with respect to the assumptions made in relation to the Without investment scenario. The key one was that equivalent alternative approaches to GRDC investment in MUP would have been developed over the period to 2014.

The contributions from the two components of total benefits that were measured are presented in Table 17.

Table 17: Contribution of the Sources of Benefits to Present Value of Benefits

Source of Benefit	Contribution to Present Value of Benefits (%)
Disease losses avoided	61
Additional profitability of pulse crops	39
Total	100

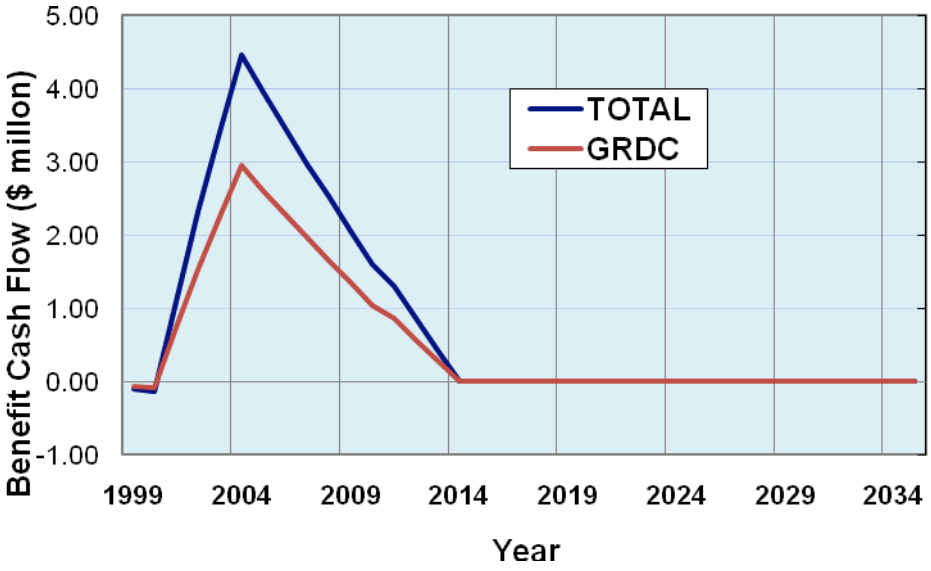

Figure 1: Annual Benefit Cash Flow

Sensitivity Analyses

Sensitivity analyses were carried out on key variables. The results are reported in Tables18 and 19. The key variables were selected to take account of assumptions about which there was most uncertainty. All sensitivity analyses were performed using a 5 percent discount rate with benefits attributed to GRDC taken over the life of the investment plus 30 years from the year of last investment. All other parameters were held at their base values.

As shown in Table 18, the results are not sensitive to the discount rate to any extent. The lack of sensitivity results from the incidence of costs and benefits over time being close together.

Table 18: Sensitivity to Discount Rate
(GRDC investment, 5% discount rate, 30 years)

Criterion	Discount rate		
	0%	5%	10%
Present value of benefits (m$)	21.5	27.9	36.4
Present value of costs (m$)	1.5	2.1	2.9
Net present value (m$)	20.0	25.8	33.5
Benefit cost ratio	14.0	13.2	12.5

Table 19: Sensitivity to Assumptions determining Disease Loss Avoided and Area of Less Profitable Crop Displaced compared with the Base Case
(GRDC investment, 5% discount rate, 30 years)

Criterion	Benefit Assumption		
	Decreased disease loss avoided, Decreased area displaced	Base Case	Increased disease loss avoided, Increased area displaced
Present value of benefits (m$)	14.4	27.9	51.9
Present value of costs (m$)	2.1	2.1	2.1
Net present value (m$)	12.3	25.8	49.8
Benefit cost ratio	6.8	13.2	24.6

The sensitivity analyses in Table 19 demonstrate that the benefits are sensitive to the disease assumptions on the major benefits, but the investment remains highly profitable.

8. Confidence Rating

The results produced are highly dependent on the assumptions made, many of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 20). The rating categories used are High, Medium and Low, where:

High: denotes a good coverage of benefits or reasonable confidence in the assumptions made,

Medium: denotes only a reasonable coverage of benefits or some significant uncertainties in assumptions made, and

Low: denotes a poor coverage of benefits or many uncertainties in assumptions made.

Table 20: Confidence in the Analysis of the Investment

Coverage of Benefits	Confidence in Assumptions
Medium	Low

9. Conclusions and Lessons Learned

The evaluation with a benefit to cost ratio of over 13 to one has clearly demonstrated that the MUP has been very valuable in giving minor crops better access to a wider range of pesticides. By simply making a useful and in-demand pesticide available, rapid adoption over the entire crop would quickly follow. Growers' needs change but it is often uneconomic for chemical companies to respond to the needs of small markets. There is an increasing cost of registering chemicals and an increasingly restraining regulatory environment.

The benefits assessed in this evaluation are from disease losses avoided by being able to use a pesticide under permit and from the resulting increased profitability of the minor crops compared with alternatives. The benefits arise from the more responsible use of pesticides under permit compared with what would have been the case in the absence of the MUP. A major qualitative benefit is the reduced risk of MRL exceedances.

Concerns raised by Pulse Australia were a key factor in GRDC beginning the MUP in 1998. The implications of off-label use were a growing threat; pulse production was expanding and community and trade concerns on pesticide use were increasing. The domestic feedgrain market was expanding and there was the risk of pesticide residues damaging the enviable reputation enjoyed by Australian grain and meat exports. Not suprisingly there was no data available on patterns of pesticide use and how they changed following the introduction of a permit. The final report of the first MUP had noted that there was no data to support a benefit cost analysis and in many case the pesticides involved were already being used without formal approval. The assumption in this evaluation was that in the main, and in the short term, growers would have continued to use the same pesticides as they had been. However, the existence of the permit would soon have ensured greater promotion and wider adoption of pesticide-based options for more profitable control of pests and diseases.

The assumptions were also guided by increasing community and grain marketer concerns over the last decade on potential and perceived risks of pesticides in terms of food safety in particular and also to the environment. The analysis was tasked with evaluating the impacts of the one hundred or more pesticides that MUP considered over the period from 1998 to 2010. The range of pesticides included those for control of invertebrate pests, weedicides or herbicides, fungicides and desiccants. To make the task tractable, the analysis concentrated on control of the major disease of pulses, ascochyta, and its possible impacts on the three major pulse crops, chickpeas, faba beans and lentils. The disease loss survey from the GRDC study by Murray and Brennan (in press) was invaluable in providing basic data on the value of control of pesticides and of contributions from agronomic measures and from improved varieties. The benefits assessed were then scaled up by value of production data to approximately account for the other minor crops, particularly various oilseeds.

The MUP has an important role in relation to over one half of the 25 grain crops subject to GRDC research levies that are classified as minor crops. Lack of good options for pest control was a serious constraint on the viability of many of the minor crops. From a grain industry perspective, minor crops have a vital role in sustaining a more diverse and therefore resilient agriculture able to respond to adverse impacts to regions and to specific crops.

The pulse industry in particular was highly dependent on the availability of fungicides to control ascochyta given the huge losses that had been incurred, for example 100,000 ha of chickpeas devastated in Victoria in 1998. The two benefits assessed were for disease loss avoided and for increased profitability from crops displaced as pulses became more profitable and less risky. The benefits were assumed to increase to a maximum by 2004 and then decline. It was assumed that in the absence of MUP, there would have eventually over the course of a decade been alternative ways developed to achieve registration of some key pesticides (pesticide use in agriculture has been subject to a number of reviews in recent years including

of approaches to regulation). In the absence of MUP, there would also have been more resistant varieties, increased research, and grower adaptations on other means of disease control and on alternative break crops. The assumptions on possibilities in the absence of MUP illustrate the importance of carefully considering the counterfactual in investment analysis.

The majority of the benefits assessed were from reduced losses achieved by a wider range of chemicals available for control of disease. But there were also considered to be substantial benefits from an increased area of pulses. The key benefits are their greater profitability in sustainable rotations including their value as a break crop. The increased range of options that MUP provided for disease control contributed to the rapid expansion of chickpeas particularly in the GRDC Northern Region.

The evaluation did consider in a qualitative way other possible benefits of MUP relating to food safety and to the environment. On balance, notwithstanding the absence of data on the environment, the effects are considered favourable from a greater compliance with good agricultural practice implicit in following label requirements for application of pesticides. Offsetting that position is the likely increased use of any pesticide that is more profitable. In relation to food safety and MUP it should be stated that Australian grain and products derived from grain have an exceptional reputation. But any exceedance for a particular crop has increasing potential for specific and collateral damage. Consumers may well be more concerned on food quality issues; but they are also increasingly subject to a wider range of poor quality information on incidents.

There was a degree of confidence in the assumptions but only in a qualitative sense. The benefits were assessed as an increased net present value of close to $40 million from the investment of $3.2 million, two thirds contributed by GRDC. The benefit cost ratio of over 13 to one showed the value a small investment can achieve by responding to regulatory requirements, in this case those pertaining to permits for registered chemicals.

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