



GM CANOLA IMPACT SURVEY

INFORMATION FOR GROWERS, ADVISERS AND INDUSTRY

“More than 1300 grower surveys were conducted to inform the GM Canola Impact Survey.

The survey examined adoption patterns; agronomic, economic and environmental impacts; and changes in attitude to the concerns regarding co-existence of GM and non-GM canola production systems.

The findings will assist industry stakeholders, policy-makers and the community better understand the actual versus perceived impact of GM canola on Australian growers and farming systems.”

David Hudson and Rosemary Richards, survey authors.



> ADOPTION PATTERNS > WEED CONTROL > CHEMICAL USE > AGRONOMY AND CROPPING SYSTEMS
> COST OF PRODUCTION > ISSUES > ENVIRONMENTAL IMPACTS > ATTITUDES > NEIGHBOURS

CONTENTS

Key findings	3
Background	4
Adoption	5
Attitudes	6
Agronomic	7
Environmental	8
Case Study: Do GM canola growers use glyphosate in the same way as the non-GM growers?	9
Economic	10
Co-Existence	11
Barriers	12

This research was conducted by David Hudson (SGA Solutions Pty. Ltd) and Rosemary Richards (Bowman Richards Consulting).

ACKNOWLEDGEMENTS

The project has been funded by the Grains Research and Development Corporation (GRDC) and the Birchip Cropping Group (BCG). BCG thanks the growers who participated in the survey, assisting the project team to collate the information to inform the improvement of our farming systems.

FOR FURTHER INFORMATION CONTACT:



Birchip Cropping Group
Phone: 03 5492 2787
Email: info@bcg.org.au



Grains Research and Development Corporation
Phone: 02 6166 4500
E-mail: grdc@grdc.com.au

DISCLAIMER

This publication has been prepared in good faith on the basis of information available at the date of publication.

The authors warrant that they have taken all reasonable care in producing this report. Although all reasonable efforts have been made to ensure accuracy, the authors do not warrant that the information in this report is free from errors or omissions.

Readers are responsible for assessing the relevance and accuracy of the content of this publication.

The authors, Birchip Cropping Group (BCG) and the Grains Research and Development Corporation (GRDC) do not accept any form of liability, be it contractual, tortious, or otherwise, for the contents of this document or for any consequences arising from its use or any reliance placed upon it.

The authors, Birchip Cropping Group (BCG) and the Grains Research and Development Corporation (GRDC) will not be liable for any loss, damage, cost or expense incurred or arising by reason of any person using or relying on the information in this publication.

Products may be identified by proprietary or trade names to help readers identify particular types of products but this is not, and is not intended to be, an endorsement or recommendation of any product or manufacturer referred to. Other products may perform as well or better than those specifically referred to.

This report was not commissioned to look at the safety of GM crops. For questions on the safety of GM Crops please refer to the Office of the Gene Technology Regulator (<http://www.ogtr.gov.au/>) or Food Standards Australia New Zealand (www.foodstandards.gov.au).

KEY FINDINGS



- > When compared to Triazine Tolerant (TT) canola, growers utilising GM Canola achieved more effective weed control, reduced overall pesticide use and improved farming practices (such as enhanced conservation tillage), lower risk of herbicide resistance developing and a lower environmental foot print.
- > Effective weed control, in particular control of priority weeds such as herbicide tolerant annual ryegrass and wild radish were primary reasons why growers planted GM canola.
- > There was an increasing trend in the level of concern expressed by both GM and non GM canola growers in relation to the development of glyphosate herbicide resistance. In response GM canola growers adopted alternate weed control practices, including the adoption of an alternate knockdown herbicide (paraquat/diquat) and the use of the 'double knock' technique prior to planting GM canola.
- > Over the three year survey, there was no significant difference in canola yields reported between GM and non GM canola.
- > Overall GM canola growers were more likely to use conservation tillage practices than non GMcanola growers.
- > On average the cost of weed control using GM herbicide tolerant canola was higher than that of alternate non GM canola weed management programs.
- > The economic impacts of GM canola were variable due to the initial lack of access to GM canola varieties adapted to the major canola growing regions, the cost of access to the GM technology and grain marketing/ logistic issues.
- > Concerns relating to co-existence failed to materialize with the majority of GM canola and non GM canola growers reporting no impacts on their farming operations. The issue of coexistence has not influenced farmers' choice in opting to grow GM canola or whether to increase the area of GM canola grown.
- > GM and non GM growers participating in the survey indicated that they would increase their adoption of GM canola in the future.
- > The major barrier to adoption of GM canola is the perceived lack of economic value derived from the Roundup Ready® canola technology package (i.e. the cost of access + the cost of weed control + yield + farm gate grain price + logistics costs) when compared to the established economic value of the alternate non GM weed control management system options.

BACKGROUND



In total, 1346 farmer surveys were conducted from 2008 to 2010. Of these, 968 surveys were with non-GM farmers and 378 with GM farmers.

The Grains Research and Development Corporation (GRDC) commissioned the Birchip Cropping Group (BCG) to undertake a survey which assessed the impacts of the first genetically modified (GM) canola, Roundup Ready®, available to farmers in New South Wales (NSW) and Victoria.

The survey assessed the impact of GM herbicide-tolerant canola on the farming operations of farmers growing GM canola exclusively, those growing both GM and non GM canola

and farmers growing non GM canola exclusively. The key focus areas of the survey were adoption patterns; agronomic, economic and environmental impacts; and changes in attitude to the concerns regarding co-existence of GM and non-GM canola production systems.

The GRDC commissioned the report to gain a thorough understanding of how the new technology impacts Australian growers. As such, the GRDC conducts regular grower surveys to gain an insight into how new research and development affects growers' farming systems and operations.

The report is unique because it uses real-time information collected from a statistically relevant sample of GM and non-GM growers from when GM canola was first introduced in 2008. The survey, which was conducted via telephone, tracked a series of quantitative and qualitative questions over three canola growing seasons (2008, 2009 and 2010).

ADOPTION

Did you know?

The total area of canola planted in Australia is 2.687 million hectares, which yields 4.226mt. Of this, around 740,000ha is genetically modified. *Australian Oilseeds Federation*

GM canola received Australian regulatory approval on human health, safety and environmental grounds from the federal regulator, the Office of Gene Technology Regulator (OGTR), in 2004. However, due to concerns over market access and co-existence of GM and non-GM production systems, most state governments placed a moratorium on GM production until such time as these issues were resolved by the grains industry.

In 2008, the NSW and Victorian moratoriums were lifted by their respective governments and 108 growers chose to plant Roundup Ready® canola. In 2009, 382 growers planted GM canola followed by a decline in 2010 to 314 growers. Despite the numbers of growers declining in 2010, the area planted to Roundup Ready® increased.

The area of canola grown by survey participants increased during 2009 and 2010 relative to the area grown in 2008. The area planted to TT canola maintained market share dominance throughout the survey, followed by imidazolinone tolerant canola, GM canola and conventional canola (Table 1).

The major barriers identified in 2008 to the adoption of GM canola were:

- > access to GM canola varieties with a range of maturity types adapted for growing across the geographically large and climatically diverse states of Victoria and New South Wales,
- > geographic access to the Roundup Ready® canola technology, and
- > flexibility in the Roundup Ready® canola system (e.g. use of tank mixtures).

By 2010, the majority of these barriers had been addressed and resolved.

Table 1: Area of canola planted by survey participants

Area of canola planted by Survey Participants ²	2008 (ha)	2009 (ha)	2010 (ha)
Conventional canola	10,545	15,305	24,984
Triazine Tolerant canola	56,327	49,017	62,529
Clearfield® Canola	16,854	27,449	44,012
Roundup Ready® Canola	6,908	22,162	23,890
Total Area of Canola	90,634	113,933	155,415

ATTITUDES

Effective weed control and control of priority weeds such as herbicide tolerant annual ryegrass and wild radish were primary reasons why growers chose to grow GM canola.

During the survey the majority of respondents (>85%) reported that the weed control efficacy achieved within GM canola was either 'better than' or 'about the same' when compared side by side to that achieved in non GM canola.

Farmers were asked if they were satisfied with their experience growing GM canola, with specific regard to the impact on their management practices. Respondents nominated the following management benefits resulting from their adoption of GM canola:

- > Better weed control, in particular control of herbicide resistant annual ryegrass;
- > Greater flexibility in management such as planting early rather than waiting to control weed germinations prior to planting;
- > Having the option to 'dry sow' allowing more timely planting of other crops;
- > Early crop vigour following emergence allowing the crop to establish an early leaf canopy which competes out weeds and reduces the potential need for multiple post-emergent herbicide applications, and
- > Improvement of crop performance in moisture stress conditions (i.e. 2008 drought) due to early vigour in establishing root systems and leaves.

Overall across the three years of the survey the majority of respondents growing GM canola (>95%) were satisfied with their experience, however, the number not satisfied with growing GM canola ranged from 1.5% in 2008, to 3.9% in 2009 and 4.9% in 2010.

Respondents nominated a number of reasons as to why they would not be growing GM canola in the following year including:

- > lack of access to marketing/delivery points
- > cost of access to the GM canola technology
- > poor experience in the previous year
- > lack of value delivered
- > lack of fit in rotation
- > lack of suitable paddocks for the GM canola technology (i.e. either paddocks with heavy weed burden or the presence of herbicide resistant annual ryegrass)

AGRONOMIC



The survey compared the performance and impact of Roundup Ready® canola against the various non-GM canola weed control management systems such as Conventional Canola, Triazine Tolerant (TT) canola and Imidasolinone (IMI) Tolerant Canola (Clearfield Canola®). The survey found that the greatest benefits were gained when Roundup Ready® replaced TT canola (which, at the time of the survey represented an estimated 65-75 % of the total area planted to canola in NSW and Victoria). In comparison to TT, Roundup Ready® growers reported that they achieved:

- > More effective control of grass and broadleaf weeds: Growers found that GM canola allowed more effective control of weeds in particular, herbicide tolerant annual ryegrass (*Lolium rigidum*);
- > Reduced weed control programs: Weed control programs applied by farmers were reduced by GM growers (average of 61 programs in TT canola verses 12 in GM canola);
- > Reduced use of pre-emergent soil residual herbicides (area treated 26% less);
- > Reduced use of high risk Group A herbicides (-86%) and moderate risk Group C herbicides (-100%);
- > Replacement of atrazine and simazine herbicides used including active ingredients applied (-54%); pre-emergent soil residual herbicides (-44.6%); and post-emergent soil residual herbicides (-97.9%);
- > Reduced (-48%) reliance on and use of glyphosate for knockdown weed control prior to crop establishment;
- > Enhanced adoption of conservation tillage practices
- > Increased flexibility in crop management, especially relating to 'time of sowing' and 'weed control' operations; and
- > A lower environmental foot print (using the Environmental Impact Quotient (EIQ/ha).

While these benefits were demonstrated when comparing Roundup Ready® canola to TT canola, they were not necessarily of the same magnitude or present when compared to the alternate non-GM canola weed control management systems (i.e. Conventional canola and Clearfield® canola). For example when compared to Roundup Ready® canola, both conventional canola and Clearfield® canola growers reported more favourable gross margins.

Roundup Ready® canola when compared to Conventional canola and Clearfield® canola delivered reductions in the:

- > number of weed control programs;
- > range and use of tank mixtures;
- > use of high risk (Group A & Group B) and moderate risk (Group D & Group I) herbicides;
- > frequency of cultivation and the use of high soil impact cultivation equipment.

ENVIRONMENTAL

The adoption of Roundup Ready® in preference to Triazine Tolerant canola led to a lowering of the environmental foot print from growing canola (using the Environmental Impact Quotient¹ (EIQ/ha). This was achieved through a reduction in the use of both pre-emergent and post-emergent herbicides, primarily Group C herbicides (i.e. atrazine and simazine). These Group C herbicides are soil-active, residual herbicides with a higher risk of soil and groundwater contamination. Data showed that when GM growers replaced the application of Group C herbicides they reduced the active ingredients applied (-54%).

Specifically, the data showed that the GM canola weed management systems, in comparison to TT:

- > reduced the pre-emergent herbicide environmental foot print by 56%;
- > reduced the post-emergent herbicide environmental foot print by 49%; and
- > reduced the cumulative weed control program environmental foot print by 60%.

The GM canola weed management systems also allowed growers to achieve enhanced adoption of conservation tillage practices including:

- > reduction (-29%) in the use of cultivation for weed control;
- > increase (+39%) in the use of low soil impact cultivation equipment for weed control;
- > increased (+5%) use of direct drilling equipment for crop establishment; and
- > reduction in the consumption of diesel fuel (-16%) and emissions of compounds such as carbon dioxide, carbon monoxide and oxides of nitrogen)

When compared to the application of all herbicide groups applied across all non GM canola weed control programs, the adoption of GM canola reduced the use of pre-emergent soil residual herbicides (-44.6%) and post-emergent soil residual herbicides (-97.9%). Further, the survey found that in relation to the application of herbicide groups which are at risk to weeds developing herbicide resistance, respondents growing GM canola within and between years were less likely to apply:

> High-risk herbicides:

- Group A - clethodim (Select®), haloxyfop (Verdict®), quizalofop (Targa®) as part of a post-emergent weed control program.
- Group B - triasulfuron (Logran B®), chlorsulfuron (Glean®) as part of a pre-emergent weed control program.
- imazamox/imazapyr (Intervix®), imazapic/imazapyr (On Duty®) as part of a post-emergent weed control program.

> Moderate-risk herbicides:

- Triazine (Group C) herbicides as part of either pre-emergent and/or a post-emergent weed control program.
- Trifluralin (Group D) as part of a pre-emergent weed control program.
- Glyphosate (Group M) as part of a pre-plant knockdown weed control program.

¹ Readers should, note that the EIQ is an indicator only and does not take into account all environmental issues and impacts - it is therefore not a comprehensive indicator.

CASE STUDY: DO GM CANOLA GROWERS USE HERBICIDES IN THE SAME WAY AS THE NON-GM GROWERS?

To ensure the sustainable use of glyphosate where Roundup Ready® is being used as a weed control system, farmers need to ensure that they adopt resistance management strategies recommended for the use of glyphosate. This includes use of the Paddock Risk Assessment Management Option Guide (PRAMOG) model and recommendations highlighted in the WeedSmart campaign (<http://www.weedsmart.org.au/>).

During the survey there was an increasing trend in the level of concern expressed by both GM and non GM canola growers in relation to the development of glyphosate herbicide resistance (Table 2).

Table 2. Farmers attitude towards the development of herbicide resistance (Glyphosate)

"I believe Roundup Ready® canola will cause herbicide resistance problems"	2008 (%)	2009 (%)	2010 (%)
Roundup Ready® canola growers			
Agree	12.3	30.6	49.2
Neutral	50.7	18.4	15.3
Disagree	37.0	51.0	35.5
Non GM canola growers			
Agree	39.4	69.0	68.7
Neutral	41.6	11.9	10.2
Disagree	19.0	19.1	21.1

In response to this concern growers adopting GM canola, increasingly reduced the use of glyphosate as their dominant knockdown herbicide applied for weed control prior to planting (-48%) in preference to the adoption of a range of alternate weed control options including:

- > Adoption of the Group L herbicide SparySeed® (paraquat/diquat) as an alternate knockdown herbicide either applied as a stand-alone herbicide or in combination with glyphosate as part of the 'double knock'² technique, and/or
- > Increased the use of cultivation for weed control prior to planting, and/or
- > Increased the use of trifluralin for pre-emergent weed control prior to planting.

By contrast the majority (>90%) of farmers growing non GM canola continued to use glyphosate as their knockdown of choice for weed control prior to planting non GM canola.

Despite concerns about development of glyphosate resistance, there was an increasing trend for farmers to apply two applications of glyphosate for post-emergent weed control in GM canola. During the survey period farmers growing Roundup Ready® canola increased the use of multiple (x2) applications of glyphosate (+33.9%) for in-crop post-emergent weed control. As a result, these farmers were less likely to apply one or more grass selective post-emergent herbicides when compared to farmers growing non GM canola.

² The most commonly practiced double knock technique includes a full label rate of glyphosate followed up by a full label rate of paraquat/diquat within 1-14 days. This technique utilizes herbicides with different modes of action and ensures any weeds surviving the glyphosate application or newly germinated weeds will be controlled.

ECONOMIC



During the survey period, the average variable cost of weed control⁴ in Roundup Ready® canola was higher than the non-GM canola weed control management systems. However, all weed control systems demonstrated a range of costs depending on the weed control program applied. These included (in Australian dollars):

- > Roundup Ready Canola: \$58.08/ha (\$37.70/ha – \$75.73/ha)
- > Clearfield® Canola: \$46.16/ha (\$9.81/ha – \$93.06/ha)
- > Triazine Tolerant Canola: \$38.70/ha (\$9.25/ha – \$88.20/ha)
- > Conventional Canola: \$25.12/ha (\$7.62/ha – \$44.45/ha)

The difference in costs between GM canola and the alternate weed control management systems in canola are attributed to the:

- > Technology Access Fee for the Roundup Ready® canola technology. This fee does not apply to the non-GM weed control management systems.
- > Increased use of the pre-emergent herbicide trifluralin for complimentary control of herbicide-resistant annual ryegrass.
- > Increased use of multiple applications of glyphosate for in-crop, post-emergent weed control, increasing from 16.1% in 2008 to 50.0% in 2010.

Farmers overall assessment as to whether Roundup Ready® canola was 'value for money' declined over the survey period (table 3).

Table 3: Farmer attitude as to whether GM canola is "value for money"			
"I believe GM canola technology is 'value for money'."	2008	2009	2010
GM Canola grower respondents	%	%	%
Agree	30.5	50.9	41.0
Neutral	62.2	19.9	22.1
Disagree	7.3	29.2	36.9
Non GM canola grower respondents	%	%	%
Agree	22.9	22.4	20.2
Neutral	49.6	20.8	20.4
Disagree	27.5	56.8	59.4

Growers identified a number of barriers which emerged during the survey that have and continue to impact the value and adoption of GM canola, these included:

- i. the initial lack of access to GM canola varieties with a range of maturity types adapted for growing across the geographically large and climatically diverse states of Victoria and New South Wales;
- ii. the cost of access to the GM herbicide tolerant technology; and,
- iii. marketing / logistic issues associated with disposal of GM canola grain.

CO-EXISTENCE



Respondents growing GM canola and those growing non GM canola were asked a series of attitudinal questions relating to different facets of the coexistence of GM canola and non GM canola. In each year of the survey, the majority (70%-95%) of respondents growing GM canola reported that they were also growing non-GM canola.

The survey found that concerns relating to the co-existence of GM and non GM canola crops prior to the introduction of GM canola have failed to materialize, with the majority (84% - 89.3%) of GM canola respondents indicating that they had not received any complaints relating to their growing of GM canola. Of the complaints received, these primarily related to:

- > Pre-existing beliefs that GM canola should not be grown.
- > Concern about the impact on non-GM products, such as canola, honey, dairy.
- > Concerns about developing glyphosate-resistant weeds.

Of those that did receive a complaint, proportionally the number of complaints relating to the growing of GM canola declined during the survey period (15.9% - 10.7%).

Even though during the study period there was an increase in the area and proximity of GM canola being grown in NSW and Victoria, consistently the majority (92.6% - 94.9%) of non GM canola growers indicated that the GM canola crops being grown did not have an impact on their farming operation.

As a result, co-existence has not been a major factor influencing grower behaviour in terms of farmers living amicably with their neighbours or within the broader farming community. Nor has the issue of co-existence influenced farmer's choice in opting to grow, or not to grow, GM canola or whether to increase GM canola area.

BARRIERS



Throughout 2008 and 2009 growers identified a number of barriers to the adoption or expanded use of GM canola, including:

- > Limited range of cultivars available with the glyphosate tolerance trait, together with the relatively narrow range of maturity types - this significantly limited the grain growing regions in which GM canola could be adopted (decreased from 36% in 2008 to 18% in 2010);
- > Potential risks associated with the development of herbicide resistance in weeds (i.e. glyphosate), potentially resulting in its loss for pre-plant knockdown weed control across the crop rotation (Increased from 12% to 49% for GM growers and increased from 39% to 69% for non GM growers);
- > Preference to observe the experience of other growers before adopting (decreased from 26% in 2008 to 5% in 2010)
- > Lack of access to retail outlets which were approved to license and sell GM technology to farmers (decreased from 25% in 2008 to 4% in 2010);
- > Cost of access to the glyphosate tolerant technology in GM canola (increased from 13% in 2008 to 20% in 2010 as a proportion of the variable weed control cost);
- > Need for improved marketing options for grain produced from GM canola (increase from 30.5% in 2008, to 67.2% in 2010), including the need for better access³ to delivery sites (i.e. more delivery sites, shorter distance and lower freight cost); and
- > A more competitive 'farm gate' pricing structure for GM grain relative to that offered for non-GM canola grain (i.e. AUD\$10 - AUD\$15/t higher price for non GM grain during the survey period);

By 2010, some of these barriers had been addressed. However, a range of issues emerged which up until the end of the survey in 2010 continued to act as barriers to the adoption and/or expansion of GM canola. In order of importance these were:

- > Cost of access to the "Roundup Ready® canola technology package (i.e. Technology Fee + Planting Seed Cost + Herbicide Cost)³;
- > Lack of access to grain delivery sites for GM canola, resulting in higher freight costs and reduced flexibility in marketing options.
- > The differential in "farm gate" prices offered by grain marketers for GM grain (-\$10 - \$15/t)⁴ versus non-GM canola.

Overall, the survey indicated that the major barrier to the wider adoption of GM canola is the perceived lack of economic value derived from the Roundup Ready® canola technology package (i.e. the cost of access + the cost of weed control + yield + farm gate grain price + logistics costs). Despite this, the overall sentiment expressed by GM and non GM growers was positive towards GM canola and indicated that they would increase adoption of GM canola. The positive sentiment expressed potentially reflects respondent's recognition of some benefits of GM canola including: i) effective weed control, especially the increasingly prevalent weeds that have developed herbicide tolerance; ii) the positive environmental and agronomic impacts; and iii) the increased flexibility in management at critical times of the year.

³ Authors Note: For the 2012 and 2013 canola growing seasons Monsanto announced changes to the Technology Access Fee for the Roundup Ready® canola technology. The impact of these changes on adoption has not been assessed as part of the current survey.

⁴ All values are in Australian Dollars (AUD\$)



GM CANOLA IMPACT SURVEY

INFORMATION FOR GROWERS, ADVISERS AND INDUSTRY

