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Will Genetically Modified Canola be Adopted in WA?

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Abstract

Despite approval being given by the Gene Technology Regulator to plant genetically modified (GM) canola varieties in Australia, the question as to whether farmers would be prepared to grow GM canola is still being explored. The purpose of this paper is to establish not only if producers would grow GM canola in south Western Australia but how they make this decision. Results from a survey aimed at canola producers found that adoption of GM canola will ultimately depend upon price premiums for non-GM canola and personal risk likely to be incurred by growers.

Keywords: canola; genetically modified crops, adoption.

Introduction

The Federal Government in Australia responded to consumer and industry demands for regulation of genetically modified (GM) crops by introducing the Gene Technology Act and establishing the Office of the Gene Technology Regulator (OGTR). In 2003 the OGTR approved as safe for humans and the environment the GM canola Bayer® CropScience's® InVigor®, resistant to the herbicide LibertyLink® (gluphosinate) (OGTR 2003c) and Monsanto's® Roundup Ready® canola variety, resistant to the herbicide Roundup® (glyphosate) (OGTR 2003b). However, as all canola-growing States have a moratorium preventing the release of GM canola for broad-scale agriculture, commercial release is potentially stalled (Chance 2003, Government of Victoria 2003). Even so, as the OGTR (2003a) acknowledge, it is expected that the commercial release of GM canola in Australia will see the first GM crop to be grown for human consumption in Australia. The question is whether farmers will be prepared to grow GM canola?

The OGTR's decision to approve GM canola for release has been criticised because economic considerations were not included as part of the decision on the safety of the crop to humans and the environment (Foster *et al.* 2003). Specifically the marketing implications of GM canola have not been considered for GM canola adopters, conventional or organic canola growers, or the grain marketers when supplying other grains (Foster 2003). Each individual grower's decision to adopt will depend on how easily GM canola can be incorporated into their farm production system, the economic impact it will have on their farming enterprise, and their personal ethical and moral beliefs regarding GM technology.

In 2004 GM canola varieties increased to 19% of total canola planted (up from 13% in 2003) with the US and Canada being the only producers (James 2004). GM crop adoption in the US is attributed to the simplicity and flexibility of the weed control program (Carpenter and Gianessi 1999). GM crops are also popular due to their fit with the trend towards conservation tillage practices and narrow row spacing (Carpenter and Gianessi 1999, Fernandez-Cornejo and McBride 2000). US producers have been placed at an advantage over Australian growers for three main reasons; (1) there are no labelling requirements for the US domestic market, (2) the US population overall is less concerned about GM safety and (3) growers receive government benefits for adoption (Fulton and Giannakas 2004, Kingwell 2000). In Canada in 2004 Roundup Ready and Liberty Link varieties were grown on 75% of the production area, while Clearfield varieties (herbicide resistant through traditional plant breeding methods) were produced on 18% and conventional varieties on 7% . The driving factors behind adoption in Canada have been easier weed management and a better yield, potentially providing a higher return to growers over conventional canola (Canola Canada 2005, Fulton and Keyowski 1999). Other reasons identified include; reducing farm costs through fuel savings and reduced herbicide use, earlier seeding, and easy removal of unwanted weeds from fields (Canola Canada 2000, Serecon Management Consulting Inc and Koch Paul Associates 2001).

Reasons for non-adoption of GM canola in Canada focus on the increased cost of the 'Technology Use Agreement' paid to the biotechnology or seed companies by growers, control of volunteers in the following crop, and required isolation between fields (Canola Canada 2000, Serecon Management Consulting Inc and Koch Paul Associates 2001). Growers have also expressed concerns over market access and developing resistance in weeds due to pollen flow or gene transfer (Canola Canada 2000, Mayer and Furtan 1999, Serecon Management Consulting Inc and Koch Paul Associates 2001, Smyth *et al.* 2002).

Following the commercial release of GM canola, Australian growers will most likely be caught between perceived problems with market availability and the agronomic advantages of reducing input costs and increasing yields. Canola genetically modified for herbicide resistance potentially offers Australian growers the advantages of earlier sowing, better and easier weed control, replacement of low yielding Triazine tolerant (TT) canola[1], integrated weed management, increased rotational flexibility, increased production area matched with minimum tillage, reduced pesticide use and fuel savings (Norton 2003). Nevertheless, Australian growers will not necessarily receive the same advantages from GM canola as Canadian and US growers as the growing environment and market forces affecting Australia are different (Baumann *et al.* 2002) and the factors determining GM crop adoption are location and farmer specific (Fernandez-Cornejo and McBride 2000).

The Kondinin Group (2003) surveyed 1029 of their Australian grower members regarding GM crops and found 19% were in favour of GM crops, 45% were against and 36% were unsure. Data for Western Australian grower members were 14%, 52% and 30% respectively. Biotechnology Australia (2003) found 40% of canola growers would grow GM crops, an increase from 25% in 2001, while 54% remained against growing these crops. McDougall, Longnecker, Marsh and Smith (2001) surveyed Western Australian pulse farmers regarding GMOs in agriculture and found farmers had a high level of interest in GMO issues, with particular concern about socio-economic implications of the marketing of GMOs and the control of GM technology.

The study presented was conducted in 2003 to determine not only if canola growers in the Great Southern Region of Western Australia would adopt GM canola, but the reasons that drive their decision making. This paper outlines the findings of this study by considering the characteristics of the survey sample, grower attitudes and perceptions about GM canola and analyses aimed at determining GM canola adoption.

Methodology

Adoption model

Adoption is defined by Lindner (1987) as the process whereby a grower determines whether or not to use a new technology. The adoption process, according to Rogers (1995), is the sequence of gaining knowledge, persuasion to trial, decision to trial and confirmation leading to the decision to adopt or not. Every grower, whether they adopt or not, follows this process of adoption; how long the process takes determines if they are innovators, early adopters, early majority, late majority, or laggards (Rogers 1995).

Grower adoption is primarily dependent on profitability, initial cost, risk and complexity or learning required for the technology, all of which are variety specific attributes (Adesina and Zinnah 1993, Batz *et al.* 2003, Marra *et al.* 2003). The overriding factor determining farmer decision-making and so adoption though is profitability (Byerlee and Hesse de Polanco 1986, Lindner 1987). Profitability is measured at an individual crop level as well as a whole farm production level, so GM canola must be perceived as having a relative advantage over the conventional variety and must be of benefit to the whole farm production system if it is to be included in the cropping rotation (Pluske and Lindner 2001). Growers' net returns and adoption decision would be affected by whether the yield-increasing potential of crops genetically modified for herbicide resistance offsets the higher cost for GM seed and whether savings in herbicide use are realised (Lin 2002). Premiums have been observed in the market place for GM products which offer benefits to the consumer, known as second generation GM crops (Burton *et al.* 2002, Marshall 1998). Third generation GM crops, incorporating pharmaceuticals, are also expected to receive a premium due to their consumer benefits (Burton *et al.* 2002).

Survey

The Great Southern Region was selected as the study region since it is the predominant canola growing region of WA with around 1,100 grain growers (ABARE 2005, CBH 2003, Crowe and Pluske 2005). A sample of 600 was taken from a random selection of 3,000 residents listed in the WhitePages® directory for the Great Southern Region of WA and asked to participate in the survey. The survey package sent to growers consisted of a cover letter, a non-response form, a questionnaire and a reply paid envelope. The non-response form allowed the recipient to indicate why they did not complete the questionnaire so non-response could be more accurately explained and any non-response bias recognised.

Results

Survey Response

Of the 600 surveys sent, 78 were returned to sender thereby giving a survey sample of 522. Of the survey sample 36% returned the non-response form and 14% the completed questionnaire (Table 1). Most producers (around 85%) who returned the non-response form did so because they did not grow canola now or have no intentions of doing so in the future. The remainder were not happy about this topic or simply did not like completing surveys.

Table 1. Total grower population, with response rates for survey.

	No. of Individuals
Grain growers in Great Southern	1,100
Surveys posted	600
Returned to sender	78
Survey sample	522
Non-response form: respondents	188
Questionnaire: respondents	71

Sample Characteristics

The demographics questions in the survey asked respondent’s gender, age and highest completed education level. The majority of respondents were male, with only two being female. The average age of respondents was between 30 and 40 years and the highest level of education completed by respondents was primarily high school.

The questionnaire also asked the grower’s total production area, canola area, tonnes harvested and budget expectations. The average arable farm area was just over 2,800 ha with around 1,300 being used for cropping and of that almost 300 ha was allocated to canola production (Table 2). The average canola harvest per grower was a fraction over 400 tonnes, providing an average yield of 1.4 t/ha. The majority of respondents expected a surplus budget in 2003.

Table 2. Proportion of canola growers anticipating a GM canola yield advantage above current canola yields and a non-GM canola price premium above current prices.

GM canola yield advantage (%)	Growers (%)	Non-GM canola price premium (%)	Growers (%)
0	36	0	48
5	25	5	17
10	27	10	16
15	12	15	19

Expectations of GM Canola Yield Advantage and Non-GM Canola Premium

The canola growers surveyed primarily did not expect a yield advantage from GM canola or a price premium for non-GM canola. Testing for independence indicates that there were significant differences between these observations and an equal proportion of growers expecting changes in yield[2] or price premium[3].

Producers' intentions to adopt GM canola

Of the canola growers who responded to the survey, 37% would grow canola genetically modified for herbicide resistance given their current level of knowledge while 63% would not. The planting intentions of growers subject to GM canola yield advantage and non-GM canola price premium are detailed in Table 3. It was found that growers are less likely to plant GM canola if a price premium is available for non-GM canola. Furthermore, growers are more likely to plant GM canola if a yield advantage is anticipated and this benefit is greater than the benefit due to a price premium.

Table 3. Proportion of growers intending to plant non-GM canola and/or canola genetically modified for herbicide resistance based on 0, 5 or 10% increase in yield of GM canola or price premium of non-GM canola.

	% of Growers intending to grow various canola types		
GM Yield Advantage and non-GM Price Premium	GM canola	non-GM canola	GM and non-GM canola
0% GM yield advantage 0% non-GM price premium	13	81	6
0% GM yield advantage 5% non-GM price premium	4	81	15
0% GM yield advantage 10% non-GM price premium	6	87	7
5% GM yield advantage 0% non-GM price premium	19	63	18
10% GM yield advantage 0% non-GM price premium	32	44	24

Grower intentions to plant GM canola, non-GM canola or both were further investigated using regression analysis. Regression analysis was performed on two of the survey questions to investigate why growers would adopt GM canola. The analysis drew on grower demographics, production statistics, attitudes toward GM canola and expected or stated GM and non-GM canola advantages. The first analysis was based on grower intention to plant GM canola given their current level of knowledge and the second on the area of GM and non-GM canola they would plant given a certain level of GM yield advantage and non-GM price premium (Appendix 1). The explanatory variables examined in this analysis included grower demographics, attitudes toward GM crop issues and expectations and statements of GM canola yield and non-GM canola price premiums, the area of canola the respondent typically plants as well as their age, budget status (surplus, deficit, or zero balance), highest level of education completed, gender and location, respondents' expectations about the yield of GM canola and the price premium for non-GM canola, as well as their attitude towards aspects of the GM crop debate.

In the first analysis of intention to adoption based on grower's current level of knowledge, the dependant variable is defined as a quantitative response variable because a discrete outcome, in this case a 'yes' or 'no' decision, is produced. Therefore, as explained by Greene (2000), a logit or probit functional form is preferred as least squares, the conventional method, does not provide adequately for the binary dependent variable. Backwards step-wise regression was performed to produce a probit function for predicting grower intention to adopt canola genetically modified for herbicide resistance given their current level of knowledge. The regression was calculated using the computer program EViews® based on log likelihood values. The results in Table 4 show that the grower's decision to adopt GM canola depends on their expectation regarding a non-GM canola price premium (EXP_PRI), and their attitude regarding the cross pollination and/or development of herbicide resistant weeds due to GM canola (AT_POLL) and the requirement for greater research into GM canola (AT_RESEAR).

Table 4. Regression equation predicting grower's intention to adopt canola genetically modified for herbicide resistance given their current level of knowledge.

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2.90	0.76	3.83	0.000
EXP_PRI	0.51	0.24	2.15	0.031
AT_POLL	-0.96	0.33	-2.89	0.004
AT_RESEAR	-0.77	0.27	-2.83	0.005

McFadden R-squared: 0.49 *LR statistic (3 df): 40.72*

Growers who believe a premium will be available for non-GM canola and so a profit advantage are less likely to adopt GM canola as the coefficient has a positive value. This regression also indicates there is a connection between grower's perception of the riskiness of GM canola due to the possibility of cross pollination and/or herbicide resistant weeds and a need for further research, and their adoption decision. From the negative value of the coefficient this indicates that growers are less likely to adopt GM if they view it as risky.

Grower Adoption Given Stated GM and non-GM Advantages

The second regression analysis based on grower intention to plant GM and non-GM canola with a stated GM canola yield advantage and non-GM canola price premium indicates why growers are likely to adopt GM canola in the future when more information regarding GM canola yields and non-GM canola prices is available. A probit function was determined for grower's intention to plant GM canola for a GM yield advantage and non-GM price premium of 0, 5 or 10% also using a backwards step-wise regression. The regression equation (Table 5) indicates that the grower's decision to adopt GM canola depends on the yield advantage provided by GM canola (GM_YIELD), grower's attitudes regarding GM canola being bad for the environment (AT_ENVIR), the requirement for greater research into GM canola (AT_RESEAR) and GM canola as a threat to export markets (AT_THREAT).

Table 5. Regression equation predicting grower's intention to adopt canola genetically modified for herbicide resistance given known GM yield advantages and non-GM price premiums.

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	4.28	0.49	8.76	0.000
GM_YIELD	-16.24	2.71	-6.00	0.000
AT_ENVIR	-0.28	0.12	-2.42	0.016
AT_RESEAR	-0.59	0.11	-5.23	0.000
AT_THREAT	-0.34	0.11	-2.98	0.003

McFadden R-squared: 0.40 *LR statistic (3 df): 128.47*

This analysis supports the initial regression findings of grower adoption dependence on profit and risk. According to the second regression analysis grower adoption is dependent on the GM canola yield advantage available, grower attitudes regarding GM canola as being bad for the environment, a threat to export markets and requiring further research. The explanatory variables, GM canola as a threat to export markets and GM canola yield, acknowledge the grower's concern about the profitability of GM canola. As the grower's perception of the profitability of GM canola decreases with the loss of markets and no yield increases, the negative coefficient value means they are less likely to adopt GM canola.

The importance of risk to the grower's decision is again recognised by the inclusion of their attitude towards the need for further research. As the grower perceives the riskiness of GM canola to increase, they are less likely to plant GM canola as the coefficient has a negative value.

Grower Attitudes to GM issues

Discriminatory power (DP) scores are used for attitude and behaviour questions as they determine the degree to which each item differentiates between high scorers and low scorers on the overall scale, for this study whether growers support or oppose GM canola. For DP scores to indicate that respondents from the lower quartile will answer the question differently to respondents in the upper quartile they must be higher than 0.5 and are preferred to be above 1.0 (Monettte *et al.* 1986). The DP scores given in Table 6 show all the attitude statements of the survey have DP scores above 1. Therefore, all questions indicate respondents who support or oppose GM canola would answer these questions differently.

Table 6. DP scores for attitude questions, of the survey.

Attitude question	DP Score
GM canola will be a threat to our export markets	2.6
GM canola will be bad for the environment	4.4
GM canola will be more profitable than non-GM canola	2.4
GM canola will be more complex to grow than non-GM canola	2.0
GM canola will not offer a yield advantage over non-GM canola	2.5
More research needs to be done before GM canola is released	2.1
Cross pollination and/or herbicide resistant weeds will eventuate with GM canola	2.1
Multinational corporations involved with GM canola have too much power	2.3
GM canola is a health risk to people	2.2

Discussion & Conclusions

Most growers will not plant GM canola given their current level of knowledge. Their intention to plant GM canola is based on their expectation about the price premium for non-GM canola, their education level and their attitude toward the profitability of GM canola, the requirement for greater research into GM canola and GM canola as a threat to export markets. Grower attitudes to GM canola being bad for the environment and the need for more research highlights the distinction between the risks of new technology to the grower personally and the risks of GM technology to the greater community. Growers will consider both types of risk when making their adoption decisions, thereby effectively making the community's decision for them.

This study's finding of 37% of canola growers supporting GM canola and 63% against is consistent with Biotechnology Australia's (2003) results. In contrast, the Kondinin Group (2003) stated that only 14% of Western Australian grower members were for GM crops, 52% against and 30% unsure. The number of growers supporting GM canola adoption is distinctly higher for our study and the Biotechnology Australia (2003) study. This is possibly due to a high number of respondents to the Kondinin Group survey being willing to trial GM canola and so indicating they would grow GM canola to this study, but while unsure about GM canola overall as questioned by the Kondinin Group.

Based on grower intentions to plant GM canola given their current level of knowledge it could be assumed that growers are profit maximisers. Growers have strong attitudes on all aspects of the GM canola debate, as the high DP scores received for all attitudinal questions illustrate, but according to the regression analysis not all of these attitudes influence their adoption decision. The analyses indicated grower's GM canola adoption decisions are influenced by their expectations of the price premium for non-GM canola, the risk of cross pollination and/or herbicide resistance of weeds and the need for further research into GM canola before it is released. Growers who believed a premium will be available for non-GM canola and so a profit advantage, are less likely to adopt GM canola. Furthermore, as the grower's perceptions of the profitability of GM canola decreases with the loss of markets and no yield increases, they are less likely to adopt GM canola. Adoption is also influenced by grower's perceptions of the riskiness of GM canola due to the possibility of cross pollination and/or herbicide resistant weeds and a need for further research, with growers being less likely to adopt GM canola if they view it as risky. The attitudes of Western Australian growers in this study are similar to those reported in McDougall et al (2001), being primarily concern about socio-economic implications of the marketing of GMOs, though less concerned about the control of GM technology. The relationship between adoption, riskiness and profitability of GM canola found in this study is also consistent with findings of Marra et al (2003). Ultimately adoption of GM canola in Western Australia will depend upon price premiums for non-GM canola and personal risk likely to be incurred by growers.

This study provides guidance on the likely number of growers adopting GM canola. Once more information is available about the determinant aspects of the GM crop debate such as GM canola yield advantages, non-GM canola price premium, cross pollination and herbicide resistance of weeds, the impact of GM canola on the environment and export markets, grower adoption behaviour could be predicted with greater certainty.

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Appendix 1

Question 5 from the questionnaire

From what you currently know, would you plant canola genetically modified for herbicide resistance?

YES NO

Question 6 from the questionnaire

How many hectares of canola genetically modified for herbicide resistance **and/or** non-GM canola would you grow given the circumstances described in the following table?

Option	Yield advantage for GM canola (above your current yield)	Price premium for non-GM canola (above current prices)	Area GM canola (ha)	Area non-GM canola (ha)
1	0%	0%		
2	0%	5%		
3	0%	10%		
4	5%	0%		
5	10%	0%		

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[1] TT canola refers to a number of conventionally bred canola varieties that are resistant to the herbicide Triazine®. It has accounted for approximately 90% of canola production each year in WA over the past 5 years. DAWA. (2005). *2005 Crop Variety Sowing Guide for Western Australia*. Department of Agriculture Western Australia, Perth.

[2] X^2 (4) = 1.064, p = 0.077 () = degrees of freedom, 95% critical value

[3] X^2 (4) = 48.23, p = 0.006