An Agronomic And Economic Assessment Of Transgenic Canola

Prepared For The

CANOLA COUNCIL OF CANADA

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TABLE OF CONTENTS

GLOSSARY OF TERMS I

1.0 INTRODUCTION 1

1.1 BACKGROUND 1
1.2 STUDY OBJECTIVES 2
1.3 STUDY METHODOLOGY 2

2.0 TRANSGENIC/CONVENTIONAL PRODUCER SURVEY 4

2.1 SURVEY METHODOLOGY 4
2.2 SURVEY RESULTS 6
2.2.1 Varieties and Seed Costs 6
2.3 FERTILIZER INPUTS 8
2.4 HERBICIDE INPUTS 9
2.5 OPERATIONS (LABOUR AND EQUIPMENT) 14
2.5.1 Seeding Operations 14
2.5.2 Herbicide Applications 15
2.5.3 Fertilizer Applications 15
2.5.4 Tillage and Harrowing Operations 15
2.5.5 Combined Operations 16
2.6 MISCELLANEOUS INPUTS 17
2.6.1 Scouting 17
2.6.2 Irrigation 17
2.6.3 Other Operating Costs 17
2.6.4 Equipment Investment and Divestiture 18
2.7 YIELD, GRADE AND REVENUE 18
2.7.1 Yield 18
2.7.2 Dockage 18
2.7.3 Grade 19
2.7.4 Revenue 19
2.7.5 Grower Reported Return per Acre 20
2.8 AGRONOMIC PRACTICE CHANGE 20
2.8.1 Canola Acreage and Rotations 20
2.8.2 Seeding Practices 20
2.8.3 Conservation Tillage 21
2.8.4 Weed and Volunteer Canola Management 21
2.8.5 Crop segregation 21
2.8.6 Services and Rentals 21
2.9 HISTORY OF TRANSGENIC USE 21
2.10 ATTITUDES TOWARD TRANSGENICS 22
2.10.1 Benefits and Reasons for Using Transgenics 22
2.10.2 Disadvantages and Reasons for Not Using Transgenics 22
2.10.3 Impact if Transgenics Were No Longer Available 23
2.11 SUMMARY 23
2.11.1 Summary Per Acre Costs and Revenue 23
2.11.2 Summary Contribution to Agri-Business 24
2.11.3 Summary Agronomic Impacts 24

3.0 CASE STUDIES 25
3.1 Description Of Case Study Operations 26
3.2 Agronomics Practices 28
3.2.1 Variety Selection and Acreage of Production 28
3.2.2 Tillage and Planting Practices 28
3.2.3 Fertilization Practices 29
3.2.4 Weed Management Practices 29
3.2.5 Soil and Water Conservation Practices 30
3.2.6 Harvest Methods and Timing 30
3.3 Financial Performance 30
3.4 Environmental And Social Aspects 31
4.0 ECONOMIC ANALYSIS 32
4.1 Introduction And Approach 33
4.2 The Canola Industry Economic Model 33
4.2.1 Structure 33
4.2.2 Data Assumptions 34
4.3 Economic Model Results 36
4.3.1 Direct Economic Impacts 36
4.4 Environmental Impacts 42
4.4.1 Herbicide Use 42
4.4.2 Fertilizer Use 43
4.4.3 Fuel Consumption 43
4.4.4 Transgenic Canola's Impact On Canola Prices 43
4.4.5 Long Term Impacts of Transgenic Canola on Prices and Exports 45
4.5 Secondary And Multiplier Impacts 45
4.6 Economic Analysis Summary And Conclusions 47
4.6.1 Direct Economic Impacts 47
4.6.2 Aggregate Impacts 48
4.6.3 Opportunity Costs 48
4.7 Indirect And Induced Impacts 48
4.7.1 Multiplier Impacts 48
4.7.2 Total Economic Impacts 48
4.7.3 Impacts On Canola Prices 49
4.8 Environmental And Resource Use Results 49
4.8.1 Herbicide Use 49
4.8.2 Fertilizer Use 49
4.8.3 Fuel Savings 49
5.0 SUMMARY AND CONCLUSIONS 51
5.1 Agronomics 51
5.2 Economic Analysis 51
5.2.1 Direct Effects 52
5.2.2 Indirect and Induced Effects 53
5.2.3 Summary of Economic Impacts 53
5.2.4 Market Responses 53
5.3 Environmental And Social Aspects 53

LIST OF FIGURES AND TABLES

Figure 1.1 Study Methodology 3
Figure 3.1 Percent of Varieties Grown 28
Figure 3.2 Percent of Acres Grown 28
Figure 4.1 Economic Approach 33
Figure 4.2 Per Acre Results, Transgenic Canola 37
Figure 4.3 Per Acre Results, Conventional Canola Varieties 37
Figure 4.4 Gross Margin Analysis 38
Figure 4.5 Acres in Transgenic and Conventional Canola 38
Figure 4.6 Annual and Cumulative Economic Impacts of Transgenic Canola 40
Figure 4.7 Direct Economic Impact, Producer Survey Estimate 40
Figure 4.8 Opportunity Costs of Transgenic Canola 41
Figure 4.9 Summer Fallow Opportunity Costs 41
Figure 4.10 Relative Use of Herbicides (tonnes) 42
Figure 4.11 Transgenic Canola Impact on Herbicide Consumption 42
Figure 4.12 Fuel Savings for Transgenic Canola 43
Figure 4.13 Canola Prices and Production, 1982-2000 44
Figure 4.14 Trends in Selected Commodity Prices, 1982-2000 44
Figure 4.15 Multiplier Impacts of Transgenic Canola 46
Figure 4.16 Cumulative Direct and Secondary Impacts of Transgenic Canola 47

Table 2.1 Sample and Margin of Error by System 4
Table 2.2 Sample Distribution by Geography 5
Table 2.3 Percentage of Transgenic Growers Planting Each Variety 6
Table 2.4 Percentage of Conventional Growers Planting Each Variety 6
Table 2.5 Seeding Rate 7
Table 2.6 Seed Type 7
Table 2.7 Computed Seed Costs 8
Table 2.8 Transgenic Fertilizer Costs 8
Table 2.9 Conventional Fertilizer Costs 9
Table 2.10 Transgenic Herbicide Inputs 10
Table 2.11 Conventional Herbicide Inputs 11
Table 2.12 Transgenic : Fall 1999 and Spring/Summer/Pre-harvest 2000 Herbicide Applications 12
Table 2.13 Transgenic 1999 Summer Fallow Herbicide Applications 13
Table 2.14 Conventional : Fall 1999, Spring/Summer/Pre-harvest 2000 Herbicide Applications 13
Table 2.15 Conventional 1999 Summer Fallow Herbicide Applications 13
Table 2.16 Cost of Seeding Operations 15
Table 2.17 Cost of Tillage and Harrowing 16
Table 2.18 Cost of Combined Operations 16
Table 2.19 Combined Operations and Costs for Various Practices 17
Table 2.20 Cost of Scouting Operations 17
Table 2.21 Yield Before Dockage (% of Growers) 18
Table 2.22 Dockage 18
Table 2.23 Grade 19
Table 2.24 Transgenic Canola Revenue Summary 19
Table 2.25 Conventional Canola Revenue Summary 19
Table 2.26 Summary Cost Per Acre 24
Table 2.27 Summary Economic Impacts 24
Table 3.1 Source of Canola Information 26
Table 4.1 Canola Price and Yield 34
Table 4.2 Input Prices 34
Table 4.3 Total and Distribution of Acres Harvested by Canola Production System 35

Table 4.4 Comparative Per Acre Returns, Costs, and Gross Margin, Crop Production Year: 2000 36
Table 4.5 Aggregate Model Results, Transgenic Canola 39
Table 4.6 Aggregate Model Results, Conventional Canola..39
Table 4.7 Summer Fallow Opportunity Costs 41
Table 4.8 Fuel Savings – Transgenic Canola 43
Table 4.9 Commodity Price Correlations 44
Table 4.10 Economic Multipliers 46
Table 4.11 Accumulative Economic Impacts of Transgenic Canola Production Systems 49
Table 5.1 Producer Per Acre Estimates 52
Table 5.2 Direct Economic Impact...52

Glossary Of Terms

Transgenic/Genetic Engineered (GE)/Genetically Modified Organism (GMO)	A transgenic plant contains genetic material artificially acquired from another organism by the technique of genetic modification or engineering. Codex Alimentarius sets international food standards under the Food and Agriculture Organization of the United Nations. Their current definition states "genetically engineered/genetically modified organism means an organism in which the genetic material has been changed through gene technology in a way that does not occur naturally by multiplication and/or natural recombination". Examples of these techniques used in gene technology include: recombinant DNA techniques that use vector systems; techniques involving the direct introduction into the organism or hereditary materials prepared outside the organism; and cell fusion or hybridization techniques that overcome natural barriers.
Herbicide Tolerant (HT) Varieties/Systems	Plants that have been developed to be resistant to specific herbicides. There are five systems in canola which are considered to be herbicide tolerant: triazine tolerant (resistant to the herbicides such as atrazine); Roundup Ready (resistant to the herbicide glyphosate/Roundup); Liberty Link (resistant to the herbicide Liberty); SMART or Clearfield (resistant to Odyssey and Pursuit herbicides); and, Navigator (resistant to the herbicide Compas).
Transgenic Canola	In canola there are five groups of varieties that are considered transgenic, or genetically engineered. They are: Roundup Ready (resistant to the herbicide glyphosate/Roundup); Liberty Link (resistant to the herbicide Liberty); InVigor hybrids (special hybridization system); high laurate canola (Calgene development); and the recently introduced Navigator (resistant to the herbicide Compas). For the purposes of this study, the transgenic varieties examined were Roundup Ready, Liberty Link, and InVigor hybrids (which are also Liberty tolerant). Navigator and high laurate varieties were used on a very small acreage in 2000.
SMART Trait Canola	The SMART system (now called Clearfield) is resistant to Pursuit and Odyssey herbicides and was developed through a process called mutagenesis. These SMART herbicide tolerant varieties are not considered transgenic by the international community, but are considered as plants with novel traits under the Canadian regulatory system.
Conventional Canola	Conventional varieties are not transgenic nor one of the herbicide tolerant systems and have been developed through traditional breeding methods like cross-pollination and back-crossing.

Plants with Novel Traits (PNT)	Plants with unusual traits such as herbicide resistance are regulated in Canada on the basis of the novelty of the trait and not the method used to introduce the traits. Plants with novel traits may be produced by conventional breeding, mutagenesis or recombinant DNA technology.
Integrated Pest Management	A sustainable approach to managing pests by combining biological, genetic, agronomic and chemical tools in a way that minimizes economic, health and environmental risks while maximizing economic returns.
Conservation Tillage	Any tillage and planting system that leaves at least 30% of the soil surface covered by residue after planting. Conservation tillage maintains a ground cover with less soil disturbance than traditional cultivation, thereby reducing soil loss and energy use while maintaining crop yields and quality. Conservation tillage techniques include minimum tillage, mulch tillage, ridge tillage, and no-till.
Minimum Tillage	A soil conservation system where the number of tillage passes is limited or reduced compared to conventional systems.
No-Till or Zero-Till	A method of planting crops that involves no seed bed preparation and opening the soil just enough to place seeds with minimal disturbance of the residue cover; there is usually no cultivation during crop production; and chemical weed control is normally used.
Direct Economic Impact	The net change in gross margin per acre related to the changes in direct costs, and/or revenue due to the production and marketing of canola.
Aggregate Economic Impact	The impact on the gross margin per acre due to the production and marketing of transgenic canola, aggregated over the total number of acres harvested using the transgenic production system.
Opportunity Cost	The direct impact of transgenic canola per acre, aggregated over the total number of acres which were not seeded to transgenic canola, or over the number of conventional canola acres.
Secondary/Induced Economic Impact	The additional impact due to the change in the direct economic impact on a community or region.

1.0 INTRODUCTION

1.1 BACKGROUND

Canola acres in western Canada have increased dramatically in the past few years. The 1996 Statistics Canada Census of Agriculture reported 40,974 growers producing 8.6 million acres in comparison to approximately 75,000 growers producing 13.7 million acres in 1999 and 12.1 million acres in 2000. One major impetus for the growth up to 1999 was the switch from grain (particularly wheat) due to low commodity prices. However, improved production efficiencies in canola have also likely been a factor in the increased acreage. The drop in acres from 1999 to 2000 probably resulted from low canola prices and concern over crop rotations.

Herbicide tolerant canola varieties have been rapidly adopted by western Canadian producers in the past four years. A survey of 300 canola growers in western Canada with 100 acres plus, conducted by the principals of Koch Paul Associates[1], revealed that in 1996 2% of the respondents grew Roundup Ready canola, 11% grew Liberty Link canola, and 14% grew Pursuit SMART trait canola. It appeared that most producers grew these varieties on a trial basis, as the average number of acres seeded to these varieties was less than one-third of the total acres seeded to canola by these producers.

In genetic engineering, novel genes are directly introduced to the plant. In mutagenesis, chemicals are used to induce modification of the plant's genes. In Canada, plants with novel traits are regulated by the Canadian Food Inspection Agency (CFIA). According to the CFIA, "plants in Canada are regulated on the basis of the traits expressed and not on the basis of the method used to introduce the traits. Plants with novel traits may be produced by conventional breeding, mutagenesis or recombinant DNA techniques". The result is that, in Canada, plants that have had novel traits (such as herbicide resistance traits) added through any means are equally regulated.

International consumer and market concerns, however, have focussed on plants that have been modified using the tools of genetic engineering (transgenic plants), rather than by techniques such as mutagenesis. SMART (now called Clearfield) canola was modified using mutagenesis, rather than genetic engineering. Since including SMART canola in the study would have confused the issue of assessing the impacts of transgenic canola, it was excluded for the purpose of this study.

Currently almost 80% of growers are using at least one of three herbicide tolerant systems, and over 50% using one of the transgenic canola systems on some or all of their acres in western Canada. The transgenic varieties used in this study included the Roundup Ready and Liberty Link varieties. A survey on Integrated Pest Management (IPM) in canola conducted by Koch Paul Associates in the spring of 2000 suggests that the Liberty Link variety has about 29% of the transgenic canola market, while the Roundup Ready variety has the remainder.

The transgenic canola varieties on the market today are herbicide tolerant, providing the grower with improved weed control and other benefits such as the following: reduced herbicide use in some situations; increased conservation tillage practices; earlier seeding; and acreage expansion, basically because of weed management.

The 1996 study showed the most prevalent disadvantage of the biotech varieties was higher cost per acre. Lower yields, less effective weed control, greater management requirements, and the fear of introduction of volunteer canola in future crops were other commonly named disadvantages.

Public concern regarding the introduction of transgenic varieties in general is growing, as evidenced by the attention given by the media. Efforts by the industry to communicate factually to the public are a necessity.

The industry must be aware of the agronomic characteristics of transgenic varieties, as well as the economic impact to farmers, agri-businesses, processors and distributors, and rural communities in

[1] "Biotech Traits Commercialized Survey" Context Consulting and The Advisory Group, November, 1996.

general. The information must be factual, and compared to conventional varieties, so the public and policy-makers can make rational decisions.

Serecon Management Consultants, in conjunction with Koch Paul Associates, has responded to the Terms of Reference as issued by the Canola Council of Canada, to carry out extensive primary and secondary research with western Canadian canola producers. The findings were analyzed, determining the level of agronomic and economic characteristics of transgenic canola. A comparison was then made to conventional canola varieties.

A rational discussion about transgenic canola requires information about two relationships: how farmers will incorporate the technology and how the markets will respond to the technology. This study is intended to clearly outline these two relationships; to discuss what factors impact them; and to provide an analysis of the ultimate agronomic, environmental, economic, and social impacts.

An analysis of farm level adoption requires an understanding of how and why producers change agronomic practices. The response of individual producers will be based on the adjustment of agronomic practices as a result of quantifiable economic factors and/or environmental concerns.

The response of markets to transgenic canola will rely on some of the data generated in the initial analysis. An economic model was also developed to quantify the impacts at a micro and macro level.

The end product of the analysis is a concise summary of agronomic and economic impacts of transgenic canola, at the individual farm level and the national level.

1.2 Study Objectives

The objective of this study is to *"qualify and quantify the agronomic and economic impacts associated with transgenic canola to better understand the impact it has had on agriculture in western Canada"*.

Specific focus areas, as outlined by the Canola Council of Canada in the Request for Proposal for this study were as follows:

Agronomic and Environmental Issues:

◊ determine the impact of transgenic varieties on yield and quality (grade, dockage, green seed);

◊ determine variances in canola production practices and environmental factors;

◊ determine variances in conservation tillage / fertilizer / seeding / pest control / rotations / weed control / subsequent crops / control of volunteer canola / management of weed resistance / moisture conservation / soil conservation / acreage expansion; and,

◊ quantify key agronomic/economic characteristics of transgenic canola compared to conventional systems: e.g. weed control measures, input costs, contribution margin, etc.

Economic Issues:

◊ determine the economic impact of transgenic canola on global canola pricing;

◊ determine the impact of transgenic canola on local businesses; and,

◊ determine other economic benefits and impacts.

The information from this project will be used to:

◊ quantify the impact of transgenic canola on the individual Canadian canola producer and the economy; and,

◊ respond to producer, consumer and industry questions on the impact of transgenic canola on producers, the environment and the economy.

1.3 Study Methodology

The study was completed in six distinct steps. Figure 1.1 outlines the various steps, and provides a brief overview of the anticipated outcomes.

The goals of each of the first four steps in the methodology were related to the need for the collection and characterizing of raw data by agronomic practice category and geographic location. Once this data was collected and organized, it was effectively incorporated into the economic model.

Figure 1.1
Study Methodology

Step 1: Project Planning and Orientation
Consensus of project timelines, goals, etc.

↓

Step 2: Research and Analysis of Existing Information
Summary of quantitative analysis, and complete data source listing

↓

Step 3: Survey
Produce evaluation of transgenic canola and suggested impacts by farming operation. Complete a survey of up to 600 canola producers in western Canada

↓

Step 4: Agronomic Analysis
Complete case studies with 12 producers across Manitoba, Saskatchewan, and Alberta. Complete revenue and analyses, develop technical coefficients for the economic model

↓

Step 5: Economic Analysis
Economic impacts, financial returns, and other impacts of transgenic canola

↓

Step 6: Reporting
Preliminary report for review, and final report submission

Steps 4 to 6 were dependent on a synthesis of the data from Steps 2 and 3.

To complete Step 3 a total of 650 farmers were surveyed, including 325 producers growing transgenic canola and 325 growing conventional canola.

Step 4 included 13 detailed case studies completed in Manitoba, Saskatchewan, and Alberta, covering different eco-regions and farming practices.

2.0 TRANSGENIC/CONVENTIONAL PRODUCER SURVEY

2.1 SURVEY METHODOLOGY

A survey of 650 western Canadian canola growers was undertaken in October/November 2000. Due to the inconsistency in responses, 13 cases were ultimately dropped from the analysis because of incomplete or conflicting answers.

All growers were pre-screened to:

- ◊ have been responsible for variety selection, weed and pest management decisions, fertilizer and pesticide application decisions, etc.;
- ◊ have grown at least 80 acres of canola in 2000 This restriction effectively dropped about 15% of the growers and just over 2% of the canola acres in western Canada from the survey population.; and,
- ◊ have not grown a SMART trait variety exclusively.

The study was designed to compare transgenic canolas to conventional canolas. SMART trait varieties are neither transgenic nor conventional, so were excluded from the survey where they were the only canola grown. Producers who grew a SMART trait canola, along with transgenic or conventional canola, were included, but the survey focussed on the practices and costs associated with their transgenic or conventional canola fields only.

The survey sample was managed to reflect a 50% split between conventional and transgenic system growers so that comparisons in economic performance and agronomic practices could be made between the two groups. Some respondents grew both types. In this case, the grower was asked to respond to the survey questions based on the type of which he/she grew the most acres. Further, if the respondent grew more than one variety of the system for which they were answering, he/she was requested to answer for only one variety; again the one of which he/she grew the most acres. Respondents could provide answers for the inputs and outputs for more than one field, only if those fields were treated identically in terms of seed variety, practices, and treatments, and if the yields were the same.

Table 2.1
Sample and Margin of Error by System

System	Type	Sample n=	% of Sample	Population[1] N=	Margin of Error[2]
Transgenic	Liberty Link Roundup Ready Bx	88 235 2	13% 36% <1%	21,641 growers 6,089,692 seeded acres	+/- 5.5%
	Subtotal Transgenic	325	50%		
Conventional	Polish Argentine Hybrid Argentine Open Pollinated	52 41 232	8% 6% 36%	13,005 growers 3,178,155 seeded acres	+/- 5.5%
	Subtotal Conventional	325	50%		
	Total	**650**	**100%**		**+/- 3.9%**

[1] Western Canada, 80 acres plus. Excludes SMART trait. Provided by Leger Marketing, *July 2000 Canadian Farmers' Herbicide Use Study* based on survey responses extrapolated to 2000 Statistics Canada values for seeded acres.
[2] at the 95% confidence level

Quotas were set so the survey sample would reflect the distribution of Polish (*B. rapa)* and Argentine *(B. napus hybrid)* and Argentine *(B. napus open-pollinated)* for the conventional sample, and the distribution of Roundup Ready and Liberty Link for the transgenic sample, as estimated from the Leger

Marketing and the *1999 Integrated Pest Management Practices in Canola* (IPM) study by Koch Paul Associates.

Further, the geographic distribution of the sample was controlled to ensure that the sample represented the distribution of canola farms by province and ecozone as determined by Statistics Canada.

Table 2.2
Sample Distribution by Geography

Geography	Ecozone	Sample n=	% of Sample
Alberta/BC	Boreal	74	11%
	Prairie	159	24%
	Subtotal	**233**	**35%**
Saskatchewan	Boreal	88	14%
	Prairie	228	35%
	Subtotal	**316**	**49%**
Manitoba	Boreal	18	3%
	Prairie	83	13%
	Subtotal	**101**	**16%**
Western Canada	Boreal	180	28%
	Prairie	470	72%
	Total	**650**	**100%**

The survey sample for transgenic and conventional varieties was split 50:50 for each province and ecozone in the above table. The 1999 IPM survey (n=881) revealed almost an equal percentage of adoption of transgenics in each of the two ecozones, with 52% of the growers in the prairie ecozone, and 54% in the boreal ecozone answering for transgenics. These results are based on one representative field per grower. SMART trait varieties enjoyed a higher adoption rate in the boreal ecozone (18%) as compared to the prairie ecozone (10%), as did Polish varieties: 11% for boreal (which is logical since this ecozone includes the Peace River area for which Polish varieties are well suited) and just 4% for the prairie ecozone. Comparatively, conventional Argentine varieties were lower for the boreal (17%) than for prairie ecozone (34%).
Lists were obtained on a confidential one-time use only basis from Monsanto's and Aventis' customer databases.

The survey considered:

- ◊ variety grown, seeding rates, pedigreed vs. common seed, and seed costs;
- ◊ yield, dockage, and grade, as well as self-reported net returns per acre;
- ◊ summer fallow practices, including herbicide use, on the canola field in 1999;
- ◊ fertilizer use;
- ◊ mechanical and cultural weed control; and,
- ◊ the history of transgenic use, and the impact on practice change since adopting a transgenic variety, and benefits or disadvantages to growing transgenics.

The survey was fielded from the central telephone survey facility of Vantage Research in Calgary, Alberta, following an extensive pre-test. Up to six call-back attempts were made to each valid number. The refusal to complete ratio was 0.87:1, which is considered very good for a telephone survey of this type, particularly given that no incentive to respond was provided. The disqualified ratio to completes was 2:1, largely because the quota for transgenics filled very quickly and it was difficult to find conventional growers in the population because the incidence rate is relatively low. About 10% of those disqualified planted SMART trait varieties only, while just under one-third were disqualified because they did not grow canola in 2000 or they grew less than 80 acres of this crop.

The Canola Council of Canada and the provincial grower associations were identified as the sponsors of the survey.

The economic and agronomic data collected in the survey were supplemented by an analysis of practices by conventional and transgenic growers, that were obtained from a survey of western Canadian canola growers undertaken in March/April 2000 in the 1999 crop year. (Please see the report on *1999 Integrated Pest Management Practices in Canola*, Koch Paul Associates, October 2000, conducted on behalf of the canola industry.)

Additional herbicide expenditure data were provided by Leger Marketing (formerly Criterion Research) from their *July 2000 Canadian Farmers' Herbicide Use Study*. A sample of 1,600 western Canadian growers participated in this survey (1,395 with more than 80 acres in canola and not exclusively SMART trait). Herbicide expenditures for fall 1999 applications, spring 2000 pre-seed applications, spring/summer post emergent applications, and pre-harvest intentions were provided.

The analysis approach used was to report expenditures on a per acre basis. The data were weighted to reflect the number of acres to which the applicable variable applied. Standardized seed, fertilizer, and herbicide costs were collected from various farm input supply representatives.

2.2 Survey Results

2.2.1 Varieties and Seed Costs

Tables 2.3 and 2.4 detail the varieties used by the survey sample for each system, and the certified seed prices used to calculate seed costs.

Table 2.3
Percentage of Transgenic Growers Planting Each Variety

Variety	% of Growers Planting n=321	Price Per lb (Certified Seed)
Roundup Ready Transgenic		
41P50	<1%	1.50
41P51	<1%	1.90
45A50	<1%	2.50
45A51	10%	2.90
Conquest	7%	3.65
IMC 106	<1%	3.25
LG3235	12%	3.25
LG3295	2%	3.25
LG3345	2%	3.00
LG3455	2%	3.40
LG3525	1%	3.40
LG Dawn	<1%	3.25
Quest	22%	3.30
Arrow SW	7%	2.40
RideR SW	3%	4.00
RR (unspec.)	4%	2.75
Table 2.3 (continued)		
Variety	**% of Growers Planting n=321**	**Price Per lb (Certified Seed)**
Liberty Link Transgenic		
2631LL	1%	3.25
Exceed	3%	2.00
Independence	<1%	2.00
Innovator	1%	2.00
InVigor 2153	9%	3.75
InVigor 2163	<1%	3.25
InVigor 2273	8%	3.75
InVigor 2463	<1%	4.50
InVigor 2473	<1%	4.50
InVigor 2573	<1%	4.50
InVigor 2673	<1%	4.00
InVigor (unspec.)	1%	4.00
Liberator SW	<1%	2.70
Liberty Tolerant (unspec.)	1%	3.70 (ave)
Bx		
Cartier Bx	<1%	2.50

Table 2.4
Percentage of Conventional Growers Planting Each Variety

Variety	% of Growers Planting n=316	Price Per lb (Certified Seed)
Polish Conventional		
Colt	<1%	1.00
Hysyn 100	<1%	1.00
Hysyn 110	1%	3.00
Hysyn 111	<1%	3.00
Hysyn/Hysyn (unspec.)	<1%	3.00
41P55	<1%	1.89
41P56	<1%	1.89
Parkland	<1%	1.80
Sunbeam	1%	1.00
Cash	<1%	1.00
Fairview	1%	1.79
Klondike	<1%	1.00
Maverick	1%	1.80
Reward	4%	1.00
Tobin	1%	1.00
Westwin	2%	1.00
Polish (unspec.)	1%	1.00
Table 2.4 (continued)		
Variety	**% of Growers Planting n=316**	**Price Per lb (Certified Seed)**
Argentine Conventional		
Hyola 401 Hybrid	6%	4.50
Hyperstar 100 Hybrid	<1%	4.00
Conv. Hybrid (unspec.)	3%	2.40 ave.

44A89	<1%	2.40
45A02	<1%	2.20
46A65	17%	2.40
Agassiz	<1%	1.20
Ascent	<1%	1.20
CNS 601	<1%	4.00
CNS 603	<1%	4.00
Crusher	<1%	1.50
Dynamite	3%	2.00
Eagle	1%	1.80
Ebony	4%	1.70
Excel	2%	1.20
Garrison	<1%	1.80
Global	<1%	1.80
Hi-Q	<1%	3.95
Hudson	2%	1.50
Hylite 201	1%	3.20
Impulse	<1%	1.50
IMC 105	4%	3.25
Jewel	<1%	1.80
LG3311	2%	2.20
LG3333	<1%	2.25
LG3369	<1%	2.25
LG 3388	<1%	1.50
Magellan	<1%	1.50
Magnum	2%	1.50
Millenium O1	1%	2.25
Millenium 03	2%	2.25
NEXERA 500	2%	2.90
NEXERA 705	<1%	2.90
NEXERA 710	1%	2.90
Q2	13%	2.20
Quantum	9%	2.20
Sprint	<1%	1.80
Con. Open Pollinated	2%	2.50

Note: Bin run seed was priced at $1.00/lb. All Argentine varieties not included as a hybrid are open-pollinated.

Seeding rates were somewhat higher for conventional over transgenic growers.

Table 2.5
Seeding Rate
(% of grower)

Seeding Rate/Acre	Transgenic n=321	Conventional n=316
5 lbs or less	37%	26%
6 lbs	40%	44%
7 lbs	15%	21%
>7 lbs	8%	9%

Transgenic growers were more likely to plant certified seed although the incidence was high in both groups.

Table 2.6
Seed Type
(% of growers and acres seeded)

Seed Type	Transgenic n=321		Conventional n=316	
	Growers	Acres	Growers	Acres
Foundation	3%	4%	4%	2%
Certified	90%	88%	74%	69%
Common	5%	6%	22%	28%
Don’t Know	2%	2%	2%	1%

Table 2.7 illustrates the computed seed cost by system variety group/type. Transgenic seed costs are 60% higher than conventional costs on a per acre basis.

Grower reported seed costs were about 15% less for the transgenics and 7% less for the conventionals than the calculated values in the following table.

The grower reported costs per acre for seed (excluding the Technology Use Agreement (TUA) or custom seeding costs) for transgenics (n=321) was $16.21 and for conventional (n=316) the reported costs were $11.69.

On average, the transgenic growers reported paying $16.41 for certified seed and $12.49 for common. The conventional growers reported paying $13.47 for certified seed and $7.28 for common. Again, bin run seed was assigned a value of $1.00 per pound.

Fourteen percent of the conventional growers said their seed was bin-run or used their own seed. Just 2% of the transgenic growers used their own seed.

Table 2.7
Computed Seed Costs
(calculated on a per acre basis)

System	Transgenic				Conventional			
	Total Trans n=320	Roundup Ready n=231	Liberty Link n=87	Bx n=2	Total Conv n=316	Polish n=52	Arg Hyb n=26	Arg OP n=238
N=growers[1]	21,641	15,622	5,884	135	13,005	2,140	1,070	9,795
N=acres[1]	6,089,692	4,368,754	1,666,487	54,451	3,178,155	520,176	259,080	2,398,899
lbs/acre range	3-11	4-11	3-10	5-6	3-10	4-10	3-9	4-9
lbs/ac average[2]	5.81	5.96	5.44	5.63	6.14	6.05	5.77	6.20
$/lb	$3.30	$3.17	$3.69	$2.50	$2.04	$1.49	$4.18	$1.94
Total seed expend. by population ($ 000)	$116,739	$82,569	$33,380	$767	$39,822	$4,697	$6,246	$28,859
$/acre	$19.17	$18.90	$20.03	$14.09	$12.53	$9.03	$24.11	$12.03

[1] Total population of growers and acres derived from Leger survey and 2000 Stats Canada seeded acres. System values imputed from distribution of systems in 2000 Transgenic Canola Study.
[2] Prices obtained by Serecon (retail prices quoted for certified seed). Common seed price 50% of certified seed and foundation seed 200% of certified. Assumes TUA not included, nor seed treatments.

2.3 Fertilizer Inputs

Comparative fertilizer costs are outlined in the tables following for the two systems. Costs for transgenic are higher ($28.15) than conventional ($26.43) by just under $2.00 per acre. Extremely high values that were not reflective of current practices were removed from the calculations, as were those cases that did not report complete fertilizer information for all elements. Results were extrapolated to all fertilizer users before averaging the total number of acres in the survey population. Grower reported fertilizer costs were not obtained.

Table 2.8
Transgenic Fertilizer Costs

Element	Cents Per Pound	Range of Lbs/Acre of Element if Applied n=218	Lbs/Acre if Applied[2] n=218	Per Acre Cost if Any Element Applied[2] n=218	Total Expend. by Transgenic Population N=21,641 Growers N=6,089,692 Acres$ 000's	Lbs/Acre Total Transgenic Sample n=321 Growers	Per Acre Cost Total Transgenic Sample N=321 Growers
Nitrogen n	26.8	10-149	71.22	$19.09	$109,980	67.39	$18.06
Phosphorous	27.1	0-45	25.06	$6.79	$39,157	23.73	$6.43
Potassium	14.5	0- 50	5.89	$0.85	$4,933	5.59	$0.81
Sulphur	23.4	0-50	12.23	$2.86	$16,503	11.58	$2.71
Subtotal	25.9	NA	NA	NA	$170,573	108.29	$28.01
Micronutrients[1] n=6	NA	NA	NA	NA	$853	NA	$ 0.14
Total	**NA**	**NA**	**NA**	**NA**	**$171,426**	**NA**	**$28.15**

[1] Micronutrient costs reported by grower. All other costs are standardized costs from a fertilizer manufacturer/distributor. Blended prices for spring and fall applied N were determined.
[2] 95% of transgenic growers surveyed (and 95% of acres in the population) applied at least one element at least once.
[3] Weighted price per pound based on acres applied in transgenic sample

Table 2.9
Conventional Fertilizer Costs

Element	Cents Per Pound	Range of Lbs/Acre of Element if Applied n=214	Lbs/Acre Applied[2] n=214	Per Acre Cost If Any Element Applied[2] n=214	Total Expenditure By Conventional Population N=13,005 Growers N=3,178,155 Acres $ 000's	Lbs/ Acre Total Conventional Sample N=316 Growers	Per Acre Cost Total Conventional Sample N=316 Growers
Nitrogen	26.8	0-140	70.95	$19.01	$54,251	63.69	$17.07
Phosphorous	27.1	0-48	25.21	$6.83	$19,482	22.62	$6.13
Potassium	14.5	0-30	4.90	$0. 71	$2,034	4.41	$0.64
Sulphur	23.4	0-50	11.77	$2.75	$7,850	10.56	$2.47
Subtotal	26.0[3]	NA	NA	$29.30	$83,617	101.28	$26.32
Micronutrients[1] n=2	NA	NA	NA	$18.00	$350	NA	$ 0.11
Total	**NA**	**NA**	**NA**	**NA**	**$83,967**	**NA**	**$26.43**

[1] Micronutrient costs reported by grower. All other costs are standardized costs from a fertilizer manufacturer/distributor. Blended prices for spring and fall applied N were determined.

[2] 89% of conventional growers surveyed (and 90% of acres in the population) applied at least one element at least once.

[3] Weighted price per pound based on acres applied in conventional sample

An analysis was conducted to determine the relationship between fertilizer inputs and summer fallow. The incidence of summer fallow was approximately double for the conventional sample, relative to the transgenics. As would be expected, fertilizer inputs for those acres that were not in summer fallow in 1999 were significantly higher for both systems, as compared to those acres that were previously in summer fallow and subsequently planted to canola.

Transgenic growers without summer fallow (n=262) in 1999 spent on average, $29.81 per acre on fertilizer in 2000 or about 50% more than those with summer fallow (n=59, $20.33). Similarly, conventional growers without summer fallow (n=206) in 1999 spent on average, $31.17 per acre on fertilizer in 2000 or approximately double those with summer fallow (n=110, $15.84). Therefore, the lower fertilizer inputs for conventional growers overall, can be attributed to their summer fallow practices.

2.4 HERBICIDE INPUTS

Herbicide input analysis for the two systems revealed that transgenic inputs were about 40% lower than for conventional systems. Per acre differences are noted for all application timings in favour of transgenics.

Eighteen percent of the transgenic sample had summer fallow acres in 1999 which were seeded to canola in 2000. In total, 80% of the summer fallow acres had herbicides applied in 1999. Total acres in the transgenic population in summer fallow in 1999, subsequently planted to canola in 2000, were 934,587 (or 15% of the total 2000 transgenic acres).

Table 2.10
Transgenic Herbicide Inputs

	Summer Fallow 1999[1]	Post-Harvest 1999	Spring 2000	In Crop 2000	Pre-Harvest 2000 Intentions	Total[2]
(n=) Number of transgenic growers sampled	43	21	120	886	3	N/A
1. Total population of transgenic canola growers 80 acres plus in western Canada	------------------------------------ 21,641 ------------------------------------					
2. Transgenic canola Acres in population (with 80 acres plus)	------------------------------------ 6,089,692 ------------------------------------					
3a. Number of canola growers in transgenic population that made application	2899	415	2,868	20,980	62	100%
3b. Percentage of growers in transgenic population making at least one application	13%	2%	13%	97%	<1%	NA
4a. Number of acres in transgenic population to which product was applied for that application	750,235	120,037	797,751	5,906,877	18,742	N/A
4b. Percentage of acres in transgenic population applied with herbicides for that application	12%	2%	13%	97%	<1%	N/A
5. Total dollar spent on herbicides by transgenic population	$10,473,000	$1,571,000	$4,890,000	$66,282,000	$120,000	$83,336,000
6. Dollars per acre spent on herbicides by those applying (#5 divided by #4a)	$13.96	$13.09	$6.13	$11.22	$6.40	N/A
7. Dollars per acre spent on herbicides by total transgenic population (#5 divided by #2)	$1.72	$0.26	$0.80	$10.88	$0.02	$13.68

[1] Data from *2000 Transgenic Canola Survey*. All other data from Leger Marketing: *July 2000 Canadian Farmers' Herbicide Use Study* [Transgenic growers applying herbicides for one or more application (n=914)]. Copyright of Criterion Research Corp. 2000. Population of transgenic growers and acres derived from Leger survey and 2000 Stats Canada seeded acres.

[2] Column does not compute due to rounding

Table 2.11
Conventional Herbicide Inputs

	Summer Fallow 1999[1]	Post- Harvest 1999	Spring 2000	In Crop 2000	Pre-Harvest 2000 Intentions	Total[2]
(n=) Number of conventional growers sampled	61	60	160	375	6	NA
1. Total population of conventional canola growers 80 acres plus in western Canada	------------------ 13,005 ------------------					
2. Conventional canola acres in Population (with 80 acres plus)	------------------ 3,178,155------------------					
3. Number of canola growers in conventional population that made at least one application N=	2,626	1,590	4,096	9,435	162	NA
3b. Percentage of growers in conventional population making at least one application	20%	12%	31%	73%	1%	96%
4a. Number of acres in conventional population to which product was applied for that application N=	581,009	373,488	984,984	2,021,138	36,748	NA
4b. Percentage of acres in conventional population applied with herbicides for that application	18%	12%	31%	64%	1%	NA
5. Total dollar spent on herbicides by conventional population	$12,614,000	$5,144,000	$11,792,000	$41,729,000	$329,000	$71,608,000
6. Dollars per acre spent on herbicides by those applying (#5 divided by #4a)	$21.71	$13.77	$11.97	$20.65	$8.95	NA
7. Dollars per acre spent on herbicides by total conventional population (#5 divided by #2)	$3.97	$1.62	$3.71	$13.13	$0.10	$22.53

[1] Data from *2000 Transgenic Canola Survey*. All other data from Leger Marketing: *July 2000 Canadian Farmers' Herbicide Use Study* [Conventional growers applying herbicides for one or more application (n=510)]. Copyright of Criterion Research Corp. 2000. Population of conventional growers and acres derived from Leger survey and 2000 Stats Canada seeded acres.
[2] Column does not compute due to rounding

Thirty-six percent of the conventional sample had summer fallow acres in 1999, which were seeded to canola in 2000. In total, 65% of the summer fallow acres had herbicides applied. Total acres in the conventional population summer fallowed in 1999, and subsequently planting to canola in 2000, were 893,329 (or 28% of the total 2000 conventional acres).

While the transgenic survey was not designed to collect specific herbicide use information by brand (and this information was not purchased from Leger Marketing), an attempt was made to estimate the mix of herbicide types used, their associated costs and the number of units applied. This information was requested for the economic model so that the volume of these input variables could be compared by system. The mix of application (granular incorporated versus spray herbicides) is also relevant to the economic model because the costs of these operations are different, and the incidence of use of these two types of products varies by system.

The analysis following considered:

- ◊ the herbicide costs by type obtained from the Leger Marketing study for fall 1999 and spring/summer 2000 applications;
- ◊ the total number of applications made and the specific brand, rate and acres applied for 1999 summer fallow is information from the transgenic survey;
- ◊ the "logic" that most of the Liberty Link sample and the entire Roundup Ready sample in the transgenic group would have applied the applicable products; and,
- ◊ the distribution of types of products used (grouped into the five categories that appear in the tables below) as obtained from the 1999 Integrated Pest Management Study for Canola.

The first table in each sequence deals with the 1999/2000 canola crop cycle, while the second table addresses summer fallow applications for those canola acres subsequently planted to canola.

These values should be considered as estimates only and not indications of the market share for these products. The minimum recommended rate was generally assumed for the average rate applied per acre unless otherwise noted, and the prices used were Manufactured Suggested Retail (MSR) prices (Appendix 2).

Note: For fall 1999 and spring/summer/pre-harvest applications on the canola field, none of the Roundup Ready transgenic growers were assumed to have used Liberty in addition to Roundup (100% use Roundup). Seven (7%) percent of the Liberty Link growers were assumed to have also used Roundup. Also, 85% of Liberty growers would have used Liberty and 15% would have planted a Liberty Tolerant variety but did not use a corresponding product.

Table 2.12
Transgenic : Fall 1999 and Spring/Summer/Pre-harvest 2000 Herbicide Applications

Product	% of Growers Applying[1] (if applied) n=462	Estimate # Acres Applied in Population[4] N=6,023,356	Unit	Weighted \$/unit [1] if > 1 product	Average Applied per acre[3]	Weighted \$/acre[1] (if applied)	\$/acre (Total Population)[4] N=6,089,692
Roundup	74%	4,450,000	l	\$ 8.99	1.14 l[2]	\$10.29	\$7.52
Liberty	22%	1,325,000	l	\$17.00	1.1 l	\$18.70	\$4.07
All others	4%	240,000	Variable			\$10.14	\$ .40
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**\$11.96**

[1] Weighted prices for other sprays and incorporated herbicides were estimated from the distribution of applications of the applicable products, source: *1999 Integrated Pest Management in Canola Study*. Prices per unit 2000 MSR.

[2] Roundup includes other glyphosates: Assume two in crop plus fall applications per grower. Assume one application of Liberty at 1.11/ac (Alberta Agriculture Food & Rural Development Crop Protection 2000" Blue Book rates). All others were assumed to be one application.

[3] Average of recommended application rate (if a range recommended).

[4] Population numbers from Leger Marketing, derived from *July 2000 Canadian Farmers' Herbicide Product Use Study.*

Table 2.13

Transgenic 1999 Summer Fallow Herbicide Applications

Product	% of acres applied[1] (if any applied) n=43	# acres applied in Population[2] N=750,235	Unit	Weighted $/unit if > 1 product[3]	Average applied per acre[4]	Weighted $/acre (if applied)	$/acre[3] (Total Population) N=6,089,692
Roundup	100%	750,235	l	$ 9.22	1.33 l	$12.26	$1.51
All others	15%	112,500		variable		$11.40	$ .21
Total	**NA**	**NA**	**N/A**	**NA**	**NA**	**NA**	**$1.72**

[1] Summer fallow herbicide use from *2000 Transgenic Canola Study*.
[2] Population numbers from Leger Marketing, derived from *July 2000 Canadian Farmers' Herbicide Product Use Study*.
[3] Prices per unit 2000 MSR.
[4] Roundup includes other glyphosates: Assume 1.33 applications per grower applying : 1 l/acre per application. Assume 1 application for all others.

Table 2.14
Conventional : Fall 1999, Spring/Summer/Pre-harvest 2000 Herbicide Applications

Product	Growers Applying (if applied) n=119	Estimate # Acres Applied in Population[4] N=2,906,253	Unit	Weighted $/unit[1] if > 1 Product	Average applied per acre[3]	Weighted $/acre[1] (if applied)	$/acre (Total Population)[4] N=3,178,155
Roundup	32%	930,000	l	$ 8.99	1.11[2] l	$9.98	$2.98
Other Sprays (liquid e.g. Poast, Assure, Lontrel)	44%	1,279,000	l	$78.57	.145 l	$15.76	$6.39
Other Sprays (e.g. Muster)	25%	726,000	gr	$1.87	8 g	$14.96	$3.47
Incorporated (e.g. Treflan/Edge)	44%	1,279,000	kg	$ 1.84	7.66 kg	$14.08	$5.72
Total	**NA**	**NA**	**N/A**	**NA**	**NA**	**NA**	**$18.56**

[1] Weighted prices for other sprays and incorporated herbicides were estimated from the distribution of applications of the applicable products, source: *1999 Integrated Pest Management in Canola Study*. Prices per unit 2000 MSR.
[2] Roundup includes other glyphosates: Assume 1.5 applications per grower at 0.75 l/application. Assume 1 application for all others.
[3] Average of recommended application rate (if a range recommended).
[4] Population numbers from Leger Marketing, derived from *July 2000 Canadian Farmers' Herbicide Product Use Study.*

Table 2.15
Conventional 1999 Summer Fallow Herbicide Applications

Product	% of Acres Applied[1] (if any applied) n=62	# acres applied in Population[2] N=581,009	Unit	Weighted $/unit if > 1 Product[3]	Average Applied per Acre[4]	Weighted $/acre (if any Applied)	$/acre[2] (Total Population) N=3,178,155
Roundup and other glyphosate	50%	291,300	l	$ 9.16	1.25 l	$11.45	$1.05
Other Sprays (liquid e.g. Poast, Banvel, 2, 4-D, Advance, Fusion, Lontrel)	23%	134,000	l	$42.40	.50 l	$21.20	$.90
Other Sprays (granular e.g. Muster)	17%	96,100	gr	$2.20	8.75 g	$19.25	.58
Incorporated (e.g. Treflan/ Edge)	50%	290,500	kg	$2.42	6.50 kg	$15.75	1.44
Total	**NA**	**NA**	**N/A**	**NA**	**NA**	**NA**	**$3.97**

[1] Summer fallow herbicide use from *2000 Transgenic Canola Study*.
[2] Population numbers from Leger Marketing, derived from *July 2000 Canadian Farmers' Herbicide Product Use Study*
[3] Prices per unit 2000 MSR.
[4] Roundup includes other glyphosates: Assume 1.25 applications per grower applying 1 l/acre per application. Assume 1 application for all others.

Grower reported herbicide costs, including 1999 summer fallow applications, if applicable, but not including custom application were as follows:

- ◊ Transgenic (n=321) $16.22 per acre
- ◊ Conventional (n=316) $21.72 per acre

While the grower reported value for conventionals was within the margin of error range with the calculated value from the tables above ($22.53), the grower reported values for transgenics was somewhat higher than the calculated costs ($13.68). This may be partly explained by the pre-harvest product use. The Leger marketing study provided pre-harvest intention data only (data collected July 2000), while the grower reported costs would have included actual pre-harvest costs.

Had the transgenic growers only planted a conventional variety, they anticipated their herbicide costs per acre would have averaged about 8% more. A total of 37% of the growers felt the herbicide costs would have been comparable, 18% thought they would have been higher, and 44% thought they would have been lower. Those respondents saying that they thought their costs would be higher indicated a factor of 52% more (n=44), while those stating that it would be lower averaged only a few cents per acre.

2.5 Operations (Labour and Equipment)

2.5.1 Seeding Operations

Fifty percent of the transgenic growers and 35% of the conventional growers said they direct seeded the particular canola field they were being surveyed about in 2000. The cost of the seeding operation, as provided by the participants, independent of any other operations performed in combination with seeding, was 7% higher for the transgenic growers, over the conventional growers. This result is due to the differing proportions of acres direct seeded between the two samples.

Table 2.16
Cost of Seeding Operations

Seeding Method	Cost/Ac for Operation	Trans. n=321	Con. n=316
		% of acres	
Direct Seeding	$12.00	57%	40%
Regular Seeding	$ 8.00	43%	60%
Total Seeding Cost Per acre	NA	$10.28	$9.60

2.5.2 Herbicide Applications

The average number of applications of herbicides made by the transgenic sample (n=321) was just over two. About 90% of these applications were made in the fall of 1999 or spring/summer 2000, with 10% being made on the 1999 summer fallow acres subsequently seeded to canola in 2000.

Virtually all transgenic growers applied a herbicide and almost none applied a granular incorporated herbicide, therefore, they did not combine a herbicide application with their seeding operation.

Assuming all herbicide applications for transgenics were sprays, none were made in combination with seeding, and the average cost per acre to apply herbicide sprays was $4.00, then the total cost per acre to apply herbicides for the transgenic sample was $8.28 per acre.

The average number of applications to apply herbicides by the conventional sample (n=315) was 1.78. Four percent of the conventional growers said they applied no herbicides. Approximately 1.5 of these applications were made during the fall of 1999 and spring/summer of 2000, with the remaining (0.28 applications) made on the acres in summer fallow in 1999.

Just over one-quarter of the applications made by conventional growers were with granular incorporated herbicides (summer fallow and 1999 fall and 2000 spring/summer applications combined). Assuming one-half of the granular herbicide applications were made in the spring, with seeding, and the remainder in fall 1999 or on the summer fallow acres, then the number of incremental passes to apply herbicides (not in combination with seeding) was 1.55 passes.

Further, assuming a cost of $6.50 per acre to apply granular incorporated herbicides, and $4.00 per acre to apply sprays, the blended cost would be $4.65 per application. Application costs for the 1.55 passes can be calculated at $7.20 per acre. Assuming an incremental cost of $1.00 per acre to apply the remaining 0.23 passes (i.e., the incorporated herbicide applications with the seeding operation), then the total application cost for herbicides for the conventional sample would be $7.43 per acre.

The above analysis does not include herbicide applications that may have occurred in combination with a tillage operation.

2.5.3 Fertilizer Applications

Ninety-five percent of the transgenic growers made at least one fertilizer application and the same percentage of acres in this population was applied with fertilizers at least once. About 60% made one application, and 40% two applications, for an overall average (for all acres, including those to which no fertilizer was applied) of 1.30 applications.

Eighty-nine percent of the conventional growers made at least one fertilizer application and 90% of the growers in this group made at least one application. Two-thirds of the growers made only one application, while one-third made two, for an average of 1.19 applications (for all acres, including those to which no fertilizer was applied).

An averaged price for fertilizer application was determined by assuming a cost of $6.50 per acre for dry and liquid applications and $8.00 per acre for anhydrous applications. Assuming 36% of the N is put down as anhydrous, a blended application rate was set at $7.00 per acre per application.

Therefore, the cost per acre for fertilizer applications for the transgenic sample, again assuming no combinations with other operations, was $9.10 and for the conventional sample, $8.33.

2.5.4 Tillage and Harrowing Operations

Seventy-six percent of the transgenic growers tilled their canola field at least once (including operations on the previous year's summer fallow, if applicable). Similarly, 75% of the canola acres were tilled at least once. The average number of tillage operations for the total transgenic sample (including those who did not till) was 1.79 operations. Assuming a cost of $6.00 per operation for tillage, the total cost would be $10.74.

Sixty-nine percent of the transgenic growers harrowed at least once and 66% of the canola acres in the sample were harrowed at least once. The average number of harrowing operations (including those that did not harrow) was just under one per acre (.94), resulting in a cost per acre of $3.29.

Eighty-six percent of the conventional growers tilled their canola field at least once (including operations on the previous year's summer fallow, if applicable). Similarly, 89% of the canola acres were tilled at least once. The average number of tillage operations for the total conventional sample (including those who did not till) was 2.63 operations. Assuming a cost of $6.00 per operation for tillage, the total cost would be $15.78.

Sixty-five percent of the conventional growers harrowed at least once and 60% of the canola acres in the sample were harrowed at least once. The average number of harrowing operations (including those that did not harrow) was .84, resulting in a cost per acre of $3.29.

These per acre cost results for tillage and harrowing represent these operations as if they were performed independent of any other operation. Some of these operations may have occurred in combination with another type of operation (seeding, herbicide or fertilizer application), which would lessen the average cost per acre.

Again, operations on 1999 summer fallow, subsequently planted to canola in 2000, are included in the Table 2.17. For the transgenic sample, 28% of the growers used chemical fallow only, 24% tilled, and 47% did both. Predictably, the conventional growers put more emphasis on tillage (36%), and just 18% reported chemical fallow alone, with 45% doing both.

Table 2.17
Cost of Tillage and Harrowing

Operation	Cost/ac[1] per Operation	Per Acre	Trans. n=321	Con. n=316
Tillage	$6.00	Average # of Operations	1.79	2.63
		Average Cost for Operations	$10.74	$15.78
Harrowing	$3.50	Average # of Operations	.94	.84
		Average Cost for Operations	$3.29	$2.94
Total Tillage and Harrowing	Trans. $5.14 Con. $5.39	Average # of Operations	2.73	3.47
		Average Cost for all Tillage Operations	$14.03	$18.72

[1] Compiled by Serecon

2.5.5 Combined Operations

Because several of the above operations may be performed in combination with others, an analysis was conducted to estimate the impact of the combined operations. There was a total of 401 (n=637) different combinations of transgenic/ conventional, summer fallow in 1999 (or not), direct or regular seeding, number of herbicide applications, number of fertilizer applications and number of tillage and harrowing operations.

The assumed prices for the operations calculations were as follows:

- ◊ direct seeding - $12.00;
- ◊ not direct seeding - $8.00;
- ◊ foliar herbicide app - $4.00 (applied to transgenic operations only;
- ◊ foliar + incorporated herbicide app - $4.65 (applied to conventional operations only);
- ◊ tillage - $6.00;
- ◊ harrowing - $3.50;
- ◊ fertilizer alone - $7.00; and,
- ◊ incremental fertilizer or herbicide cost - $1.00.

Table 2.18
Cost of Combined Operations

	Transgenic n=321	Conventional n=316
Average # Combined Operations Per Acre	6.36	7.07

Average blended cost per operation	$5.80	$5.91
Average Cost/Acre of Combined Operations	$36.90	$41.75

Table 2.19 below illustrates that the number of operations and associated costs was higher for summer fallow systems, higher for tillage regimes, and higher if direct seeding is not practiced for both the transgenic and conventional growers. Costs per acre were less for transgenics for continuous cropping, for tillage/harrowing and for both types of seeding, while costs for the conventional growers were comparatively lower if that grower had acres in summer fallow in 1999 (subsequently planted to the canola, about which we inquired) and for zero till/ harrow.

Table 2.19
Combined Operations and Costs for Various Practices

Operation	Transgenic (n=321)		Conventional (n=316)	
	# of Operations	$ per acre	# of Operations	$ per acre
Summer Fallow				
Summer fallow	n=59		n=110	
	8.61	$50.25	7.67	$45.67
Non Summer fallow	n=262		n=206	
	5.93	$34.39	6.81	$40.05
Cultivation				
Zero Till/Zero Harrow	n=46		n=26	
	4.49	28.79	4.20	27.85
Zero Till/1 Harrow	n=32		n=19	
	5.14	31.13	5.70	34.16
>Zero Till	n=243		n=271	
	6.91	39.35	7.35	43.16
Seeding				
Direct Seed Yes	n=160		n=110	
	5.60	34.54	6.15	39.47
Direct Seed No	n=161		n=204	
	7.14	39.33	7.53	42.92

The sum of the individual results for each operation from the analysis in the preceding sections of this report can be compared as follows:

Operation	Transgenic (n=321)		Conventional (n=316)	
	# of Operations	$ per acre	# of Operations	$ per acre
Seeding	1	$10.28	1	$9.60
Herbicide Applications	2.07	$8.28	1.78	$7.43
Fertilizer Applications	1.30	$9.10	1.19	$8.33
Tillage/Harrowing	2.73	$14.03	3.47	$18.72
Total	**7.10**	**$41.69**	**7.44**	**$44.08**
Average cost per operation	$5.95		$5.92	

Therefore, looking at the operations analysis, the differences between conventional and transgenic appear to be quite minor in terms of cost on a blended per operation basis, but because the conventional group is performing more operations, their costs are approximately 9% higher.

2.6 Miscellaneous Inputs

2.6.1 Scouting

An insignificant difference in time spent surveying the fields and scouting for weeds and other pests was reported.

Table 2.20
Cost of Scouting Operations

	Transgenic n=285	Conventional n=269
Cost/hour for Scouting	$10.00	$10.00
Average # hours Scouting/acre	.103	.111
Cost per acre	$1.03	$1.11

Approximately 14% of the sample could not provide an estimate of the hours spent.

2.6.2 Irrigation

Only seven growers in the total sample irrigated; one conventional and six transgenic growers. An average price per acre for annual irrigation management was estimated to be $53.50. The sample sizes are too small to compare irrigation between transgenic and conventional growers.

2.6.3 Other Operating Costs

Growers were asked if they had any other costs associated with variety selection, weed or pest control on these acres. They were also given examples of the services offered by crop consultants or agronomists and diagnostic or predictive services regarding weeds.

Ten percent of the transgenic growers reported these costs for an average of $2.87 per acre, if used (n=32). Just 7% of the conventional growers reported such costs, for an average expenditure of $10.27 (n=22) per acre if these services were used. The maximum value reported was $20.00 per acre for transgenics and $24.00 per acre for conventionals.

The per acre cost averaged over the entire population was 30 cents for the transgenic growers and 82 cents for the conventional growers.

Extrapolating to the total acres in the population, the purchase of these services is $1.8 million for transgenics and $2.6 million for conventionals.

2.6.4 Equipment Investment and Divestiture

Just under 3% of the growers of transgenic varieties had invested in equipment they otherwise would not have had they stayed with conventional varieties. Sprayers and seeders were the most common purchases. The average investment per transgenic grower surveyed was $1,521.00, or $35 million when extrapolated to the entire transgenic population.

Similarly, 3% had sold some equipment, which they otherwise would have kept, had they not grown transgenics. Examples were cultivators, seeders and chemical application equipment. The average sale price realized by all transgenic growers from the sale of equipment was $367.00. Again, when extrapolated to the total transgenic population, the total cost would be $8.5 million.

The net investment averaged $1,154.00 per transgenic grower for a total of $26.5 million, a fairly small investment when considering the number of acres, the amortization period, and depreciation.

2.7 Yield, Grade and Revenue

2.7.1 Yield

Yields were reported to be 10% higher for the transgenic system over the conventional. The average yield before dockage for the transgenics was 29.25 bu/acre, and for the conventionals, 26.54 bu/acre. Yields reached a maximum of 55 bu/acre for transgenics and 72 bu/acre for conventional canolas.

Had the transgenic growers only planted a conventional variety, their anticipated yield on these acres would have averaged 7% fewer bushels per acre. Thirty-nine percent of the growers felt the yield would have been comparable, 17% thought the yield would have been higher, and 44% thought it would have been lower.

Table 2.21
Yield Before Dockage (% of Growers)

Yield Bu/acre	Transgenic n=321	Conventional n=316
20 or less	18%	28%
21-25	19%	22%
26-30	22%	20%
31-35	21%	15%
>35	20%	15%

The yield response to varying levels of fertilizer input was charted to determine if the yield advantage for transgenics was at least partly due to higher fertilizer inputs. The results confirmed that at identical levels of fertilizer input, transgenic systems consistently out-yielded conventional systems. The yield advantage was about 2.5 bu/acre for transgenics at lower fertilizer input levels, increasing to about 3 bu/acre at the highest levels of input. Therefore, it can be concluded that the majority, if not all of the yield benefit for transgenic systems is not fertilizer dependent. Again, the higher average fertilizer inputs for transgenic systems were found to be due to the lower number of acres in summer fallow in 1999, as compared to the conventional growers.

2.7.2 Dockage

Dockage reported was less for the transgenic growers (3.87%), than for the conventionals (5.14%).

Table 2.22
Dockage
(% of growers)

% Dockage	Transgenic n=321	Conventional n=316
1-2%	24%	13%
3%	21%	17%
4%	22%	13%
5%	8%	13%

6%	5%	8%
7-9%	6%	11%
10% +	4%	14%

2.7.3 Grade

The average grade for the two systems (on a per bushel basis) was comparable, however 6% fewer conventional growers reported grade 1.

The average grade for the transgenic crop (weighted by acres corresponding to each grade reported) was 1.09 and for the conventionals, somewhat lower at 1.15 , where 1=grade 1, 2=grade 2, 3 = grade 3A, 4=grade 3B and 5=sample.

Table 2.23
Grade
(% of growers)

Grade	Transgenic n=321	Conventional n=316
#1	91%	85%
#2	6%	9%
#3A	<1%	3%
#3B	0	0
Sample	<1%	<1%

Had the transgenic growers only planted a conventional variety, 97% felt the grade would have been comparable, 2% thought the grade would have been higher, and <1% thought it would have been lower, resulting in a negligible improvement to the grade average.

2.7.4 Revenue

The revenue per acre was computed by multiplying the yield per acre, less the dockage, times the appropriate price for the grade reported from the schedule in Table 2.24 and 2.25. Adjustments were made for the contract variety growers' premium, where applicable. The revenue advantage for transgenic systems was calculated at $15.40/acre over conventional systems.

Table 2.24
Transgenic Canola Revenue Summary

Grade	n=[1]	% Acres in Sample N=6,089,692	Av Yield bu/acre	Av % Dockage	Av Yield After Dockage	Price Per Bu $[2]	Revenue per Acre [3]
1	289	93%	29.27	3.68	28.19	5.50	$155.04
2	20	6%	29.97	4.56	28.61	5.25	$150.19
3A	2	0.5%	27.11	20.00	21.68	4.25	$92.16
Sample	3	0.5%	20.93	20.16	16.71	3.25	$54.32
Subtotal	**314**	**100%**	**29.25**	**3.87**	**28.12**	**5.47**	**$153.92**
Contract Growers	1	<1% %	NA	NA	NA	<.01	$ .03
Total	**314**	**N/A**	**29.25**	**3.87**	**28.12**	**5.47 5.50**	**$153.95**

[1] No data was provided for 7 cases
[2] Price per bu compiled by Serecon. Contract grower value is $0.61/bu for IMC 106 variety, over and above base revenue for grade and yield adjusted for dockage. Source: *2000 Canola Production Centre Report,* p17, Canola Council of Canada.
[3] Values are for computed revenues, based on yield, grade, dockage and price per bu

Table 2.25
Conventional Canola Revenue Summary

Grade	n=[1]	% acres in Sample N=3,178,155	Av Yield bu/acre	Av % Dockage	Av Yield After Dockage	Price Per Bu $[2]	Revenue per Acre [3]
1	266	88%	26.86	4.82	25.56	5.50	$140.60
2	27	10%	26.08	7.47	24.13	5.25	$126.70

3A	8	2%	16.26	9.54	14.71	4.25	$62.52
Sample	2	<1%	28.82	5.82	27.14	3.25	$ 88.22
Subtotal	**303**	**100%**	**26.54**	**5.14**	**25.18**	**5.46**	**$137.37**
Contract Growers	35	9%	NA	NA	NA	.05	$1.18
Total	**303**	**N/A**	**26.54**	**5.14**	**25.18**	**5.51**	**$138.55**

[1] No data was provided for 13 cases

[2] Price per bu compiled by Serecon. Contract grower value is $0.91 for Millenium 01/03, $0.61 for IMC 105, $0.16 for NEXERA 500, and $0.45 for NEXERA 705/710 varieties, over and above base revenue for grade and yield adjusted for dockage. Source: *2000 Canola Production Centre Report*, p17, Canola Council of Canada.

[3] Values are for computed revenues, based on yield, grade, dockage and price per bu.

Only one of the transgenic growers said he was under contract as a specialty grower in 2000, whereas 35 of the conventional growers reported planting contract varieties on the field for which they answered the survey. While some of the growers may have been seed growers, none answered the survey for a field producing seed canola.

2.7.5 Grower Reported Return per Acre

The grower reported return per acre (after all input costs, labour, etc.)[2] for transgenic (n=241) was $19.92 and for conventional (n=192) $14.12.

The range in net return per acre reported by the growers was -$80.00 to +$240.00 for the transgenics and -$120.00 to +$180.00 for the conventionals. A difference of $5.80 per acre in favour of transgenics was calculated, based on these reported results. These values would have included the premium for contract varieties, the TUA (if applicable) and any other expenses the growers had recorded for these canola acres, such as custom application costs, insect and disease control, etc.

Had the transgenic growers only planted a conventional variety, they anticipated their net return per acre on these acres would have averaged $15.54 or 22% less than actually recorded. Forty-six (46%) of the growers felt the net return would have been comparable, 18% thought the net return would have been higher, and 37% thought it would have been lower.

[2] Outliers removed. Several respondents could not provide a response.

2.8 Agronomic Practice Change

2.8.1 Canola Acreage and Rotations

Of those growers that planted transgenic varieties in 2000, (n=448), 20% indicated they had increased their canola acres.

Growers who had increased canola (n=89) were queried on what their 2000 canola acres would have been if they had not grown transgenics. Average acres for these growers would be about 55% of the 2000 acres under this scenario (i.e., average acreage in canola would decline from 568 to 311 acres per grower).

When asked specifically if the growing of transgenics had allowed these growers more flexibility in their rotations:

◊ 45% said there had been no change to their rotations;

◊ 53% agreed that it allowed them to be more flexible; and,

◊ 3% felt their rotations were less flexible under transgenic systems.

2.8.2 Seeding Practices

Growers (n=448) who planted transgenic varieties in 2000 were queried as to how their seeding practices have changed since adopting transgenics:

◊ 44% said they are seeding earlier in the spring due to transgenics;

◊ 3% are fall seeding due to transgenics;

◊ 24% are seeding earlier in the spring, but not due to transgenics;

- ◊ 1% are fall seeding but not due to transgenics; and,
- ◊ 27% are not seeding earlier or fall seeding (no change).

2.8.3 Conservation Tillage

Growers who planted transgenics in 2000 (n=448) were asked how their cultivation practices changed since growing transgenics.

- ◊ 26% said their use of conservation or no-till practices has increased due to planting transgenics;
- ◊ 19% said it had increased, but not due to planting transgenics; and,
- ◊ 55% said they have not increased conservation or no-till since adopting transgenics.

Of those who have increased their use of conservation and no-till practices because of transgenics (n=115), the average increase by these growers was reported to be 69% (i.e., average acres under conservation till increased from 681 prior to adoption to 1,153 per grower since adoption). Assuming there were 21,641 transgenic growers in the population and if 26% of these growers increased conservation practices on these acres due to transgenics, then about 2.6 million acres in western Canada (5,600 growers) have been positively impacted. This does not mean that these acres would have gone from conventional tillage to no-till, but rather that the number of tillage operations may have been reduced by one operation or more.

2.8.4 Weed and Volunteer Canola Management

Of those planting transgenics in 2000 (n=448):

- ◊ 15% said weed control effectiveness has been about the same as what they would have expected with conventionals;
- ◊ 81% said the effectiveness was better; and,
- ◊ 4% said it was worse than what they had experienced with conventionals.

Similarly, regarding herbicide management to avoid weed resistance:

- ◊ 34% said it was about the same as with conventionals;
- ◊ 59% said it was easier; and,
- ◊ 7% indicated that it was more difficult.

And finally, in terms of volunteer canola management:

- ◊ 61% said it was about the same as for conventional systems;
- ◊ 16% said it was easier; and,
- ◊ 23% stated that it was more difficult.

2.8.5 Crop segregation

Seventy-two percent of those respondents who grew both transgenic and conventional varieties (n=165) said they bin their transgenic canola separately.

2.8.6 Services and Rentals

Growers who planted transgenics in 2000 (n=448) were asked if they had increased their use of any services since adopting transgenics.

- ◊ 19% increased custom application of herbicides;
- ◊ 6% increased equipment rental;
- ◊ 5% increased custom application of fertilizers;
- ◊ 5% increased their use of custom seeding; and,
- ◊ 3% increased custom harvesting.

Other factors mentioned were increased swathing and higher trucking costs.

2.9 History Of Transgenic Use

Eighty-two percent of the canola growers surveyed (recall, the sample did not include SMART trait growers, or those with fewer than 80 acres in canola in 2000) had planted transgenics at least once in the past six years. The number of growers in the sample (n=637) planting transgenics by year was as follows:

- ◊ 1995 – 7% of growers;
- ◊ 1996 – 13% of growers;
- ◊ 1997 – 31% of growers;
- ◊ 1998 – 56% of growers;
- ◊ 1999 – 70% of growers; and,

◊ 2000 – 80% of growers.

Fourteen percent of those who had ever tried transgenics (n=523) have not continued to plant them.

Thirty-six percent of the conventional sample have never planted transgenics.

Thirteen percent of the transgenic sample also planted conventionals and 22% also planted SMART trait.

Forty-eight percent of the sample who answered for conventional varieties also planted transgenics, and 21% also planted SMART trait.

2.10 ATTITUDES TOWARD TRANSGENICS

2.10.1 Benefits and Reasons for Using Transgenics

Of those canola growers adopting transgenics, (n=523) the reasons stated for initially adopting them were varied (multiple responses were given) but were centered on weed control:

◊ 50% wanted easier and better weed control overall;
◊ 19% anticipated a better yield, a better return and more profit;
◊ 18% did so specifically for grassy weed control;
◊ 15% did so specifically for annual broadleaf control;
◊ 10% did so to reduce costs;
◊ 9% first planted transgenics on a trial basis to compare with conventionals;
◊ 7% did so to clean up their fields;
◊ 7% wanted to reduce the number of passes to control weeds;
◊ 5% did so specifically for perennial broadleaf control;
◊ 3% wanted to reduce tillage;
◊ 3% did so for the ease of application of Roundup;
◊ 3% did so for chemical rotation; and,
◊ 2% wanted to be able to seed earlier and therefore to save soil moisture.

Other reasons (1% or fewer) included the following: less dockage; neighbours had good luck with it; soil conservation (direct seeding/stubble seeding, to support continuous cropping and less fallow); to avoid incorporating herbicides; to save labour; and a perception that the chemicals used are safer and not toxic to humans. Also mentioned was the perception that Roundup does not leave a residue in the soil, the influence from the seed/chemical dealer to use transgenic canola, crop rotations (especially with barley and wheat and under seeding with forages), being able to delay cropping decisions until the spring, and the control of volunteer cereals. As well they mentioned they can do multiple passes and not affect the crop, they have better timing for herbicide applications, they feel transgenic canola systems are suited to lighter soil type, they are able to control other pests by planting disease resistant transgenic varieties or mixing insecticides with Roundup, they spread out the harvest, and they were under contract as a seed producer.

When probed further, other benefits (only one or two mentions each) were less tank mixing, less wear on the equipment, reduced concern over wild mustard contamination in seed, increased ability to plant more acres to canola, and time saved banding fertilizer.

2.10.2 Disadvantages and Reasons for Not Using Transgenics

Reasons for not trying transgenics follow (n=114):

◊ 19% specifically said the cost of the TUA;
◊ 18% said the overall costs were too high;
◊ 16% were concerned with market access;
◊ 12% saw no need to change;
◊ 11% were concerned with weed resistance;
◊ 9% were worried about health concerns with GMO's;
◊ 8% didn't want to be locked into using the system chemical;
◊ 6% said they were getting the same or better yields with their conventionals;
◊ 5% specifically said the seed was too costly;
◊ 4% prefer to summer fallow; and,
◊ 3% had clean enough fields to grow conventionals.

One or two respondents each commented on such reasons as the low price of canola and the overproduction due to transgenics, a concern that GMO's haven't been tested enough, the need for more information, and the environmental conditions in their area support Polish varieties. Liberty was considered to be hard to handle and weed control was not felt to be as effective.

Similarly, among those who have tried transgenics but have not continued to plant these varieties (n=75) the reasons related to the high cost or poor economics, and concern over market and health issues with GMO's. A few were opposed to Monsanto, and some had poor experience with the variety (i.e. too tall, lodging, combine blockage) and another resented having to bin separately.

Concerns with fields being contaminated when a neighbour grows transgenics (or when transgenics are grown on the same farm with conventionals) were cited by six respondents. A few other disadvantages were stated (all single mentions), such as difficulty managing the chemical rotation prior to, or after, planting transgenics, having to swath, poor germination, more bookwork because of the chemical rebates, problems with chickweed and broadleaf perennial weeds, problems with aster yellows, inability to grow specialty varieties with transgenics, need to have bins inspected, more green seed than with conventionals, and inability to use Liberty Link because of kochia weed problems.

When prompted, of those growers who did not plant transgenics in 2000 (n=189), 51% agreed that negative public opinion toward transgenic or genetically modified varieties had been a factor in not planting them. Similarly, 47% agreed that access to markets was a factor in not planting transgenics.

2.10.3 Impact if Transgenics Were No Longer Available

The concluding question asked transgenic growers (n=448) was what they thought the impact would be on their operations if transgenic varieties were no longer available. About one-third of these respondents said there would be no impact, or they could not articulate any impact.

Of those providing an impact (n=303),

- ◊ over half were concerned about the effect on weed control and the associated costs;
- ◊ 24% would reduce their canola acres, and 10% would stop growing it;
- ◊ 10% would have to revisit their weed management techniques or go back to old practices;
- ◊ 9% would switch back to conventional varieties;
- ◊ 7% would see an impact on restricted crop rotations;
- ◊ 6% said they would get lower yields;
- ◊ 6% said their overall input costs would increase;
- ◊ 5% would increase tillage (at a higher cost);
- ◊ 5% said their management time/work to farm canola would increase overall;
- ◊ 3% thought their dockage would be higher;
- ◊ 3% would have to seed later or not seed in the fall; and,
- ◊ 3% would have to reduce continuous cropping and increase summer fallow.

Other negative impacts related to specific cost increases such as trucking, fuel, equipment in general, or difficulty managing specific aspects of their operations, seeding, fall desiccation, harvest, limited variety selection, insect management, and less flexible rotations. Some were concerned about the health risk of being exposed to more (different) chemicals, and others about the increase in soil erosion that would accompany practice change back to more fallow/tillage. Reduced crop quality was also mentioned.
A couple of respondents could see a benefit in that the market price of canola would go up (presumably due to fewer acres), and a limited few felt their costs would go down and their profits would be higher, largely due to not having to pay the TUA.

2.11 SUMMARY

2.11.1 Summary Per Acre Costs and Revenue

In summary, the economics of the transgenic system are better than the conventional system (32% better or a $10.58 net return per acre), when the variables addressed in this survey are considered.

While conventional systems report lower seed and fertilizer costs, costs for herbicides, operations, scouting and other services are higher. The revenue per acre value also favours transgenics by a factor of 11%.

Table 2.26
Summary Cost Per Acre

Input	Transgenic n=321	Conventional n=316
Seed	$ 19.17	$ 12.53
Herbicides	13.68	22.53
Fertilizer	28.15	26.43
Operations	36.90	41.75
Scouting	1.03	1.11
Other (Services not including Custom Ap	0.30	0.82
TUA (Roundup)	10.76	NA
Subtotal	109.99	105.17
Revenue	153.95	138.55
Difference	43.96	33.38

The $10.58 per acre differential between the two systems compares with the grower reported net return difference of $5.80 in favour of transgenics. One possible explanation for the discrepancy may be in the higher reported herbicide costs for transgenics (as compared to the computed costs). Another might be that the grower reported net return included other costs not addressed in the survey. It is therefore reasonable to conclude that for the 2000 crop year, transgenic systems resulted in an approximate minimum $6.00 per acre profit advantage over conventional systems.

2.11.2 Summary Contribution to Agri-Business

Comparatively, the transgenic growers collectively spent 1.9 times as much as the conventionals on seed, fertilizer, herbicides, and other inputs, and have 1.9 times as many acres. Therefore, the net contribution to the input supply industry for these purchases is virtually zero. In other words, had all growers only grown conventionals in 2000, and the total canola acres planted was unchanged, the impact on agri-business would have been negligible. Any benefit to agri-business is therefore related to a possible increase in canola acres associated with transgenic adoption, at the expense of another crop, and not due to a switching between systems. An analysis of the dollars spent on the inputs of the crop dropped for the incremental acre increase in canola, relative to the inputs spent on canola, would have to be conducted to determine this impact. Additionally however, growers reported they had made equipment purchases since adopting transgenics totalling $26.5 million (when extrapolated to the population), specifically due to switching at least some of their acres to this system.

Table 2.27
Summary Economic Impacts
(Extrapolated to total population, '000's)

Input	Transgenic n=321	Conventional n=316
Seed Purchase	$116,739	$ 39,822
Herbicide Purchase	83,336	71,608
Fertilizer Purchase	171,426	83,967
Other (not including custom applic.)	1,800	2,600
Subtotal Operating Expenses	373,301	197,997
Equipment Purchase (net of sales, specifically for transgenics)	26,500	N/A

2.11.3 Summary Agronomic Impacts

Surveyed growers reported more efficient weed control as one of the key benefits and motivators to adopt transgenics, in addition to the cost benefits illustrated by the economic analysis derived from this research. It is important to note that growers reported an improvement in weed control effectiveness and an ease in herbicide management to prevent weed resistance. They found their rotations to be more flexible, and were able to seed earlier in the spring or fall, thus benefiting from soil moisture conservation. Other benefits mentioned were harvest management and use of chemicals perceived to be less toxic or those, which leave less soil residue. Importantly, 2.6 million acres in canola rotations in western Canada have been positively impacted by increased conservation tillage practices since the introduction of the technology.

Although in the minority, non- adopters (including those who have trialed transgenics or about 20% of the population) stated several concerns. Disadvantages of transgenics were stated as the increased difficulty in managing volunteer canola, the concern with access to markets and the negative public opinion, which for some, may cast doubts on the future of this technology. Separate storing was a noted inconvenience for others. A few growers do not feel that "GMO's" and their impacts (particularly on human health) have been adequately researched. Others have not adopted, whether trialed or not, because the benefits over conventional systems are not evident, or because their particular climate, soil type or pest problems were not conducive to transgenics. These growers were satisfied with their current management system. A fairly significant number resisted the idea of paying the TUA because the costs did not justify the potential gains and a few did not want to be locked-in to a particular management system. Cross contamination of fields was also a concern.

The increase in canola acreage was perceived by a few non-adopters to be a driver of lower prices. Twenty percent of the transgenic canola growers surveyed reported that they had increased their canola acres as a result of growing transgenics. These growers reported that they would have grown 45% fewer acres in 2000, had they not adopted transgenics. Therefore, it can be concluded that about one-half million acres of current canola production (or about 5% of the total current production) is attributable to the availability of transgenics. Note that the survey population did not include growers who did not grow canola in 2000, but may have done so in previous years, thus the 5% may be overstated.

The survey results also suggest that transgenic systems result in a 10% yield advantage over conventionals, thus contributing to an overall increase in canola production. This 10% is significant both economically and agronomically in that it speaks to the overall production efficiency of transgenic over conventional systems.

3.0 Case Studies

Case studies were selected from each of the Canola Council of Canada Production Centre areas. Producers growing both transgenic and conventional canola were contacted. A pre-screening determined if they grew at least 80 acres of transgenic and conventional varieties, had records for a minimum of three years (hopefully four), and would be willing to provide us detailed information.

A total of 13 case studies were completed. Participants were interviewed in-person and questioned about their farm management, their agronomic practices, and environmental and social implications and concerns. Financial records were also provided by the case study participants.

3.1 Description Of Case Study Operations

Management decision experience by case study participants ranged from 5 to 36 years, with an average of 22.4 years. The average age of the principal manager was 45 years with a range from 29 to 61 years. Seven of the thirteen case studies were structured as family corporations, four as partnerships, and two as sole proprietorships. All of these were primarily cropping operations, with seven producing cereals and oilseeds, and an additional six including forage production, with all but one producing pulses.

The average land base consisted of 1,674 owned acres and 833 leased. Approximately 95.7% was cultivated for crops, 1.6% for hay and forage, and 2.6% was non-cultivated. On average, the participants reported 19.2 years of experience growing canola and 4.4 years of experience growing transgenic canola.

The primary source for information relative to varieties and weed and pest management was identified as input suppliers. Organizations and trade management associations were identified as good sources of information relative to varieties, marketing, production, and for weed and pest management. Basic and applied research provided information on production. Government agencies were identified as primary sources of information on crop rotations and water and soil conservation. Table 3.1 identifies the major sources of canola information by specific area.

Table 3.1
Source of Canola Information

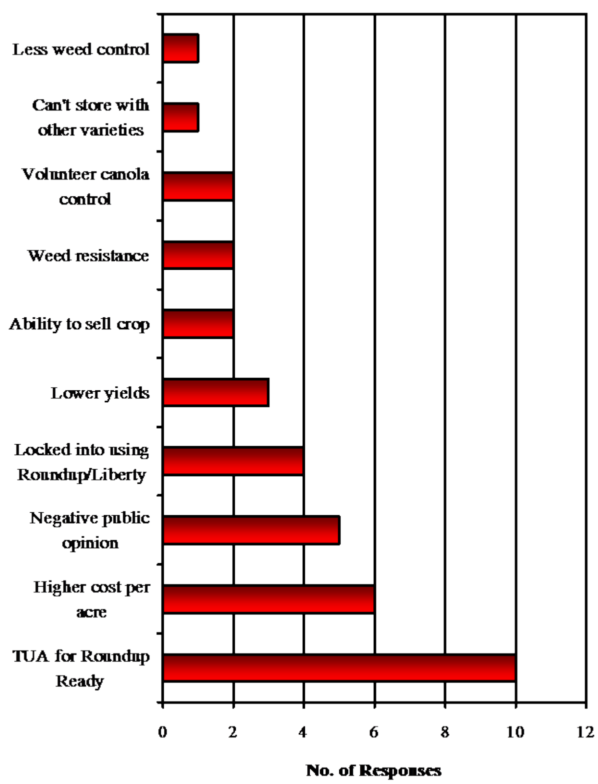
	Research	Gov't Agencies	Org. & Trade Assoc.	Input Suppliers	Consultants	Trade Magazines
Varieties	4	2	6	7	1	5
Marketing	3	4	7	4	3	2
Production	6	4	7	4	5	4
Tillage/planting	3	4	4	4	1	5
Weed Mgmt.	4	2	5	9	1	3
Pest Mgmt	4	3	5	9	1	2
Soil/Water Conservation	3	5	4			2
Crop Rotations	6	7	3	1	1	3
Financial	2	2			1	1

Note: Numbers refer to number of mentions.

The decision to grow transgenic canola was primarily due to weed control, as identified by all participants. Other reasons included yield (7 out of 13), fit into the tillage/seeding system (6 out of 13) and economics (5 out of 13). The major advantages of growing transgenic canola were attributed to weed control (all participants), diversification of canola (8 out of 13), crop rotation (7 out of 13), risk reduction (7 out of 13), and yield (5 out of 13). Producers commented that the cost of herbicides was lower, for transgenics, better weed control was possible, no-till helped moisture conservation, and transgenics allowed a wider window for chemical application.

The most prevalent disadvantage of growing transgenic canola was reported to be the TUA. Several participants did experience higher costs per acre and several also felt that the greatest disadvantage of growing transgenic canola was the negative public opinions. Responses identifying disadvantages were as follows:

Disadvantages Growing Transgenic Varieties



All of the respondents reported no technological problems when they started growing transgenics and that it was fairly easy to adopt. Six out of 13 participants indicated they had problems with weed resistance prior to growing transgenic canola. Only two of the six experienced weed resistance since growing transgenic canola. In one instance, Roundup Ready canola was found to be another weed on the farm. In another instance, weed resistance was believed to be a lesser problem. The other four participants reported successful control of millet and wild oats, with a more diverse selection of chemicals available to help avoid resistance problems. Of the seven participants who reported no weed resistance problems before growing transgenic canola, only one commented that they have some concern with volunteer canola.

Six out of thirteen participants indicated that volunteer canola management has been more difficult since they started to grow transgenic canola. Two participants had difficulty with canola in pea crops and others relied on products like 2, 4-D for spring burn-off.

Eleven participants indicated they were seeding earlier in the spring, at least partly due to planting a transgenic variety. The earlier seeding provided better opportunity for weed control. Benefits of seeding earlier were also attributed to higher yields, better weed control, earlier harvesting for risk management, an ability to spread the work load over the growing season, conservation of soil moisture, and avoiding summer heat and petal blast. Four participants indicated that transgenics fit well into fall seeding.

In a comparison of conventional and transgenic canola systems, most participants indicated transgenic was a better fit with their whole system. There was optimism relative to its yield potential. Transgenics simplified weed control and allowed more flexible rotations. Two participants did indicate however, that once you include the TUA, there was little cost advantage to transgenics.

Five participants felt that transgenic canola increased their herbicide use, while three felt the herbicide use had not changed. They felt the actual active ingredients were the same however, the chemicals were not nearly as harsh with transgenic canola. Four participants indicated that herbicide use had decreased. They were relying on a number of herbicides for conventional canola. Ten participants did indicate that transgenic canola allowed more flexibility in chemical choice. Transgenic canola was identified as being closer to the integrated pest management system. Five participants felt that canola acreage, at least in part, increased due to planting of transgenic varieties. This was attributed to the flexibility in rotations (down to 3 years).

Seven participants indicated their average yield per acre was higher with transgenics than conventional.

Better genetics, weed control, more moisture, and the ability to grow *B. napus* varieties (Argentine) contributed to this yield increase. Four participants felt there was no notable difference between the yield of transgenic and conventional canola. One participant experienced 5 to 7% less yield with transgenics.

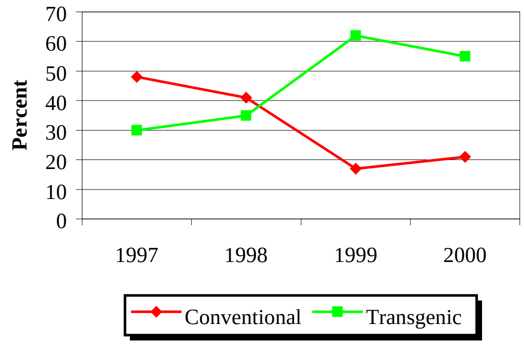
Given a choice between transgenic and conventional canola systems, twelve of the thirteen participants indicated they preferred transgenic varieties. The convenience factor, fit with current system, weed control aspects, and future yield potential, all contributed to their decision. Only one participant favoured the conventional system because of the TUA, concern with weed resistance, the additional cost of broadleaf herbicides, and volunteer canola.

3.2 Agronomics Practices

3.2.1 Variety Selection and Acreage of Production

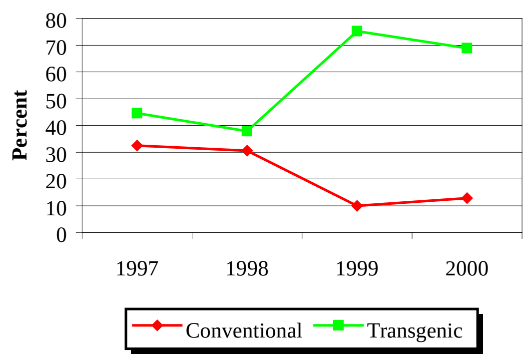
Over the four year period from 1997 to 2000, case study producers selected numerous canola varieties from three categories: conventional, transgenic and SMART trait. As a percent of the varieties grown, conventional canola has trended downward from 48% to 21%, while the transgenic varieties have trended from 30% in 1997 to 55% in 2000. SMART trait varieties grown, along with transgenic and/or conventional varieties, represented 21 to 24% of the varieties chosen during the four years. Figure 3.1 presents these trends. Producers growing SMART trait varieties were not included in the survey where it was the dominant crop grown.

Figure 3.1
Percent of Varieties Grown



Case study producers seeded 6,241 acres of canola in 1997, 7,872 acres in 1998, 7,869 acres in 1999, and 8,177 acres in 2000. During these production years, transgenic canola acres went from 44.5% of total canola acres in 1997, to 68.9% in 2000. Conventional canola acres decreased from 32.5% of total acres in 1997 to 12.8% in 2000. Figures for SMART trait canola were 23.0% in 1997 to 18.3% in 2000. The yearly percentage of total acres for each category are depicted in Figure 3.2.

Figure 3.2
Percent of Acres Grown



3.2.2 Tillage and Planting Practices

Most of the case study producers were practicing minimum tillage with many using direct seeding equipment. Eight producers indicated they have not changed their tillage and planting practices over the past four years. Four producers indicated they have changed to direct seeding, while one producer indicated in 2000 he increased tillage to avoid spring frost damage to his canola crop. Two producers changed to direct seeding in 1998, while one changed in 1997. One producer reported ongoing changes related to a variety of field conditions on rented land.

Tillage practices differed between conventional and transgenic varieties by at least one tillage pass, which was attributed to the incorporation of pre-emergent herbicides such as Edge for conventional canolas.

Other differences in tillage practices depended on fertilizer application. The number of tillage passes depended on whether fertilizer was placed with the seed or separately, such as fall banding or an anhydrous application. In minimum or no-till operations, fertilizer is usually knifed in to minimize soil disturbance in the fall.

Heavy harrows/packers were used by ten of the producers as part of their tillage regime.

Tillage costs varied from case study to case study. Harrowing costs were estimated to be $2.50 to $3.00, depending if it was light or heavy harrowing. Deep tillage was estimated to cost $4.00 to $6.00 which also represented the cost of banding fertilizer. Seeding costs varied from $5.00 to $10.00 per acre.

One producer reported that fewer operations were required with transgenics, leading to lower investment in equipment and an overall lower cost of production.

Changes in tillage practices were mainly related to the merits of conservation tillage, although the growing of transgenic canola fit well with minimum tillage and direct seeding.

3.2.3 Fertilization Practices

The application of fertilizer over the past four years has not changed significantly according to case study producers in this time frame. Only one of the case study producers indicated that he changed to fall banding of fertilizer in 1999 as an effort to conserve spring moisture. Another producer changed in 1997 to fall application of fertilizer because with his change to transgenic varieties, he no longer needed to incorporate herbicide before seeding in the spring.
The most common (six producers) application was anhydrous ammonia in the fall with a granular blend application in the spring either broadcasted or placed with the seed. Five of the case study producers applied all nutrients, usually in granular form, in the fall. One producer applied granular fertilizer in the fall on stubble fields and in the spring on summer fallow fields. Two producers broadcast nitrogen in the fall and placed the balance of nutrients with the seed.

One producer increased the fertilizer application rate by 25% on his Liberty Link crop.

Only two producers indicated they had tried micronutrients. One tried boron on a 100 acre field and another tried a phosphate boost in a blend.

Application costs varied from $3.00 per acre for anhydrous and broadcast application to $6.00 per acre for fall banding using a cultivator with sweeps.

In some cases the adoption of transgenic varieties has resulted in a change to fall placement of fertilizer. With transgenics there is no need to incorporate herbicide, thus eliminating a tillage pass. In order to conserve moisture, the tillage pass in the spring is usually eliminated, shifting the accompanying fertilizer application to the previous fall. Other than this change, most producers reported that the same fertilizer application was carried out for transgenic and conventional canolas.

3.2.4 Weed Management Practices

A common herbicide program for conventional varieties was an application of pre-emergent Group 3 chemicals such as Edge or Treflan, usually incorporated in the fall. A further application of a Group 1 and 2 herbicide such as Muster Gold, or Poast, a Group 1 herbicide, was applied in crop to control the weed population. With the change to transgenic varieties, producers reduced their use of pre-emergent chemicals and applied the appropriate chemicals such as Roundup and Liberty in-crop. Pre-seed burn-off and fall control with Roundup was a very common practice, particularly with producers minimizing tillage. Volunteer transgenic canola was usually controlled with 2, 4-D products. Noxious weeds, such as thistles, were controlled using spot applications.

Impacts of changes in weed management practices included better weed control, better yields, and less dockage. Direct seeding and in-crop weed control allow for earlier seeding (no need to wait for weed growth before seeding), increasing the probability that the crop will not flower during the hottest days of the summer.

3.2.5 Soil and Water Conservation Practices

Producers in the more southern parts of the prairies are minimizing tillage and changing to direct tillage in order to conserve moisture. With transgenic varieties, producers are eliminating the incorporation of pre-emergent chemicals and controlling weeds with in-crop applications. This change prompted one producer to change the banding of fertilizer to the fall to conserve spring moisture. Producers seeding transgenic varieties reported they achieved higher yields because of more available moisture resulting from better weed control and earlier seeding. Four producers who moved to direct seeding did so to conserve moisture. One producer commented that with transgenics, less tillage is required, resulting in the soil being firm and moist at seeding rather than dry, loose and prone to erosion. He seeds about a week earlier using transgenic canola. Another producer indicated that it is easier to get the crop established with transgenic varieties, and there is less risk of erosion and no reseeding. With less tillage, another producer indicated there would be more organic matter in the soil.

Two producers indicated they were increasing fall tillage in order to raise soil temperature in the spring.

3.2.6 Harvest Methods and Timing

There has been little change in harvesting methods or timing according to most of the case study producers. Some producers indicated that the earlier seeding had resulted in an earlier harvest due to not having to wait for spring weed growth and direct seeding. This earlier seeding has allowed for the growing of Argentine varieties which usually require swathing.

3.3 FINANCIAL PERFORMANCE

Many agricultural technologies are promoted based on their biological and environmental benefits, assuming they are also financially and economically feasible. The case study participants were asked to provide financial details relative to their canola cropping operations to help ensure that the appropriate indicators are selected for the economic analysis in the modeling component of this study. These cases studies also served to further identify extenuating circumstances and the potential range of variation that may be anticipated in the financial analysis.

Financial results for each case study participant for four years (1997 through 2000) for revenue and variable and other expenses was gathered. Caution is prescribed in interpretation of these results:

- ◊ Comparison between operations – Given the expansive area (western prairies) represented by the thirteen participants, it is reasonable to assume that the diverse ecosystems, soil types and climatic conditions will introduce variability into yield and input requirements.
- ◊ Comparison within the operation – Few case studies produced both conventional and transgenic varieties for each of the four years under examination. Even when data relative to the production of both types of canola are available, variation is experienced due to differing conditions between the fields.

Based on the individual case study data, a summary table of production, revenue, and costs was generated showing the averages and range (minimum and maximum) for key financial variables. This is included in Appendix 3.

The range demonstrates the degree of variability experienced by the participants. This is especially evident in yield estimates. With the exception of 2000, conventional varieties exhibited greater variability in yield than transgenic canola.

The number of case studies providing information varied each of the four years from 1997 to 2000 inclusive (see Appendix 3). The following tables provide averages for yields, gross revenues, variable expenses, total expenses, a gross margin, and a profit for the transgenic and conventional canola systems for the four year period. For the financial summary, SMART trait varieties were not included so as to be consistent with the balance of the study. The information throughout the case studies has not been aggregated to a total population. This is because it is too small a sample and not representative of the total population.

Average Yields
(bu/acre)

	Conventional	Transgenic
1997	25.2	26.0

1998	30.7	37.6
1999	28.7	36.1
2000	28.1	30.5

The transgenic varieties out-yielded conventional varieties over this four year period for the case studies.

The data suggest these case study participants experienced higher gross revenue from production of transgenic canola, but greater variable costs. The advantage in revenue compensated cost increases for the years 1997, 1998 and 1999. Revenue gain in 2000 did not compensate for the increase in expenses.

Average Gross Revenue *($/acre)*		
	Conventional	**Transgenic**
1997	$212.00	$219.35
1998	256.17	309.66
1999	207.63	242.92
2000	160.23	168.58

Expenses *($/acre)*		
	Conventional	**Transgenic**
1997	$139.99	$160.65
1998	135.59	134.94
1999	125.54	151.71
2000	133.45	142.35

Gross Margin *($/acre)*		
	Conventional	**Transgenic**
1997	$ 72.01	$ 58.71
1998	120.58	174.72
1999	82.08	91.20
2000	26.79	26.23

It is obvious the variability of gross revenue and gross margin is significant from year to year and between conventional and transgenic canola varieties. Refer to the detailed and summary financial information in Appendix 3.

3.4 Environmental And Social Aspects

Four of the thirteen participants expressed concern over production of a transgenic crop. In one case, the concern was expressed by an organic producer. Another concern came from neighbours who did not want transgenics in their fields. Concern was also expressed by urban dwellers and animal rights people. All of the participants believed that the public did not understand the use and production of transgenic crops. It was suggested that communications in the school system would create greater awareness of the safety of canola and canola oil.

It was believed by six participants that transgenic canola had a positive effect on the business community in the region. It resulted in more employment (consultants, seed representatives). Ten participants expressed concern over the control companies have over seed and chemicals. Many did not agree with the TUA and perceived the companies as reducing competition.

None of the participants felt that transgenic canola had impacted their ability to market canola. Some did however, indicate some reservation about the future market.

Three participants indicated they felt the public should be aware of the different methods of weed control for transgenic canola versus conventional canola. It was felt that all the chemical used for transgenic varieties had gone through proper testing and their use contributed to food safety, less tillage and soil erosion, thus better long term health of the environment. Only two participants felt that all transgenic canola products should be labelled. Others felt there were too many unknowns and labelling would give the consumers the impression there was something wrong with the product. Costs relative to labelling were also a concern.

Two participants felt that transgenic canola increased the amount and complexity of decisions relative to their operation. Timeliness was most important. Two participants felt that the amount of decisions had remained about the same. The remainder felt that the complexity had been reduced, providing greater freedom of choice for chemicals and crops.

Nine participants felt that canola had altered their soil conservation. They were able to seed into stubble, thereby ensuring a definite commitment to minimum till. Glyphosate use also allowed less tillage. The remainder of the participants indicated that soil conservation was a long term endeavour and transgenic canola was only a small contributing factor. Others had committed to a system of soil conservation and transgenics just fit into the system.

Seven participants indicated that production of transgenic canola reduced the amount of fuel used. Less working and cultivations required less fuel. The remainder felt that the fuel use was about the same.

Although most participants felt transgenic canola production had no effect on the buffer zone to water courses on their farms, one participant felt that using less tillage meant less soil was being washed into water courses and the banks were more stable. Another respondent indicated the use of burn-off meant that more fibre was still there and drainage and ridge patterns were less altered by production with transgenic canolas.

Four respondents indicated they envisioned expansion of canola acres due to transgenic varieties. Transgenics were viewed as providing less risk, better weed management, and more rotation options. The remainder of the participants were under the impression that the change had already occurred. Rotation was perceived to have been pushed to its maximum. Pricing would prohibit expansion and the market for non-genetically modified canola was perceived to be developing at a greater pace.

In general, the move toward integrated pest management often results in reducing the use of chemicals. Eight of the thirteen participants felt they now use less chemicals on their farm operation. Fields are cleaner the following year as well. Five participants did feel they had increased chemical use attributed to the practice of less tillage, however, the chemical used was perceived to be safer.

4.0 ECONOMIC ANALYSIS

4.1 Introduction and Approach

The economic analysis quantified the economic impact the introduction of transgenic canola varieties has had on western Canadian farmers between the crop years 1997 and 2000. The first year in which a significant number of farmers adopted transgenic canola seed varieties was in 1977. It was estimated that in 1997, over 15% of the canola acreage was seeded to transgenic varieties, up from 4% the previous year[3]. By 2000, almost 70% of canola producing farmers were using transgenic canola varieties on 55% of the acres.

From an economic perspective, there are two possible sets of impacts that the adoption of this new technology may have. These are as follows:

- ◊ direct impacts: the net impact on the economic returns due to the combined impacts on revenues and on operating costs from changes in key agronomic practices relating to pesticide use, fertilization, tillage, and other practices; and,
- ◊ indirect and induced impacts: the impacts on the rural communities, on the input supply industries serving the industry, on canola prices, and on other crop production in western Canada.

The economic approach was developed in an integrated fashion. The building blocks of the analysis were developed from the secondary research, the case studies, and the survey of a representative population of both transgenic and conventional canola growers within Alberta, Saskatchewan, and Manitoba. The Canola Industry Economic Model used the coefficients and parameters produced by these three building blocks in the execution of its analysis. The economic model had been used to:

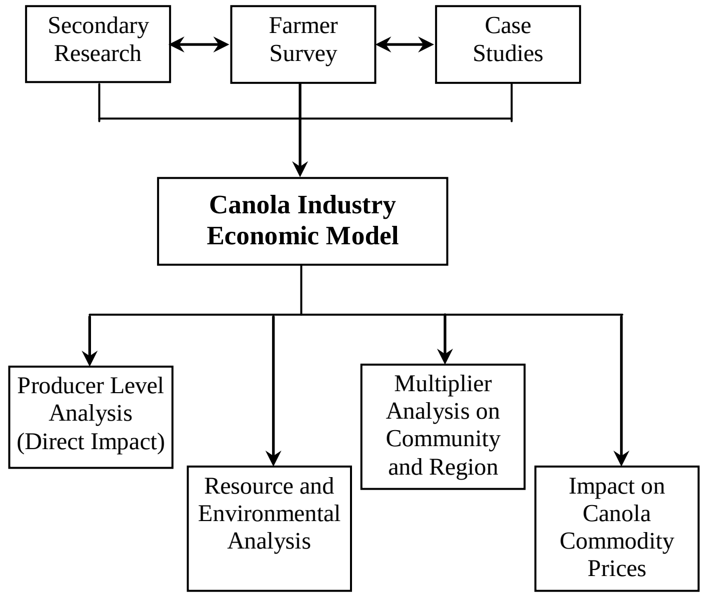
- ◊ determine the direct impact on the prairie canola producers;
- ◊ conduct an indirect assessment of the environmental impacts and resource usages; and,
- ◊ provide estimates of the multiplier impact on the broader industry and nationally.

In a separate assessment, an economic evaluation of the impact of transgenic canola production on canola commodity prices was completed.

The schematic below illustrates the logic and approach of the analysis.

[3] Canola Council of Canada, internal reports.

Figure 4.1
Economic Approach



The following section describes the structure and application of the Canola Industry Economic Model.

4.2 The Canola Industry Economic Model

4.2.1 Structure

The industry economic model was built to represent the economic impacts of conventional and transgenic canola production systems in western Canada. The major features of the model are listed below.

- ◊ The structure of the model parallels a typical farm enterprise budget, estimating the farm revenue and the cost of relevant production practices which are expected to vary between the two canola production systems. Other production costs such as depreciation, interest, administration, and overhead were not included. These factors were not considered to be impacted by the farmers choice of conventional or transgenic canola production systems.
- ◊ The model represents and simulates economic activity over the four crop production periods of 1997, 1998, 1999, and 2000.

◊ The model has three major components: one, a representation of the conventional canola production system; two, a representation of the transgenic canola production system; and three, an illustration of the differences between the two production systems.

◊ Each canola system model is comprised of three elements; a base data input table, a canola per acre enterprise budget, and an aggregate industry model. The data input table provides the detailed assumptions and calculations for the determination of the per acre revenue and costs of key management practices. The per acre enterprise budget was aggregated to represent the total population for each of the four years, based on the total number of acres in either transgenic or conventional canola production.

◊ Revenue was derived from the reported bushel yield, the average percentage dockage, and the farm level prices adjusted for the average grade received.

◊ The model aggregated the unit revenue and costs over the corresponding total estimated acreage which was devoted to transgenic and conventional canola production systems respectively over this four year period.

4.2.2 Data Assumptions

The survey data from the 637 canola growers was used in the economic model. This data set and assumptions were supplemented by the case study information.

The 2000 revenues and costs as supplied by the survey data became the benchmark for the economic analysis. The detailed calculations and assumptions have been discussed in the farm survey methodology and results sections.
From the 2000 benchmark, the revenue, cost, and gross margin calculations were estimated for the 1997 to 1999 historical period using standard techniques as discussed below.

4.2.2.1 Revenue Assumptions

Revenue was based on estimating the yield, grade, and dockage for the three historical years. The most critical parameters to estimate were the yield and price of canola between 1997 and 1999. These were estimated by indexing the actual yields and prices in 2000 for the relative changes in earlier years. Table 4.1 details these calculations.

Table 4.1
Canola Price and Yield

	1997	1998	1999	2000
Average Canadian Canola Price/t	420	373	288	256
Price Index(relative to year 2000)	1.71	1.52	1.17	1.00
Ave. Canola Production (t/ha)	1.31	1.4	1.58	1.56[1]
Yield Index	0.84	0.9	1.01	1.00

[1] Based on the producer survey of 650 western Canadian canola growers for this study.
Source: Agriculture and Agri-Food Canada (AAFA), Strategic Policy Branch, Market Analysis Division, Winnipeg, Manitoba, Supply and Disposition For Canadian Grains and Oilseeds, November 27, 2000.

To elaborate, the price used in 1997 for example, was 1.71 times greater than that used in the benchmark year, 2000. The amount of dockage and average grade were held constant to that received in 2000.

4.2.2.2 Cost Assumptions

As much as possible, relative costs over the analysis period were standardized. However, it was felt necessary to make some adjustments to reflect relative price changes for inputs. Selected input price indexes were used to backward adjust some of the major costs from the 2000 benchmark year.

The first section of Table 4.2 provides the standard farm price indexes, as well as some selected and relevant individual price indexes. The second section reveals the adjustment factor used in the model relative to the cost factor in the 2000 crop year.

Table 4.2
Input Prices

	1997	1998	1999	2000
Selected Farm Input Price Indexes (Base = 1985)				
Farm Input Price Index	126.90	127.10	127.21	129.75
Chemical Price Index	128.70	132.20	132.30	134.00
Fertilizer Price Index	123.40	114.70	106.70	121.60
Seed Price Index	124.00	126.70	124.17	125.41
Crop Production Price Index	124.90	120.70	117.08	120.01

Relative Adjustment factors (relative to prices in 2000)				
Farm Input Price Index	0.98	0.98	0.98	1.00
Chemical Price Index	0.96	0.99	0.99	1.00
Fertilizer Price Index	1.01	0.94	0.88	1.00
Seed Price Index	0.99	1.01	0.99	1.00
Crop Production Price Index	1.04	1.01	0.98	1.00

Source: Statistics Canada 62-004, Farm Input Price Index, Western Canada.

To complete the 2000 year, contact was also made with Statistics Canada to get selected indicators for first quarter. The Agricultural Input Monitoring System of the Statistics and Data Development Branch of Alberta Agriculture, Food and Rural Development was also utilized.

The crop production price index was used to measure changes in tillage, seed, and herbicide and fertilizer application costs. The chemical and fertilizer price index was used to estimate changes in chemical and fertilizer costs.

It is interesting to note that over this particular period, there were no dramatic changes in these input prices.

4.2.2.3 Distribution of Canola Acres: Transgenic and Conventional

In order to determine the aggregate impacts of transgenic canola, it was necessary to have reasonable estimates of the number of acres in transgenic and conventional canola production. Table 4.3 shows the distribution of these proportions. The number of acres in transgenic and conventional canola production were estimated using the producer survey.

The calculation of acres harvested under either conventional or transgenic production systems was determined using the following steps.

1. From the total harvested acres, the proportion (2.4%) of acreage under 80 acres were first removed.
2. The proportions of acres using the SMART trait production system were then estimated and removed from the sample. SMART trait acreage varied from 14% in 1997 to over 20% in 2000.
3. The removal of SMART trait varieties and farms under 80 acres resulted in the net relevant canola acreages which were using either conventional or transgenic production systems.
4. This acreage was then proportioned between conventional and transgenic production systems, based on the estimated adoption rate to the transgenic system. This rate varied from 15% in 1997 to 66% in 2000.

The resulting adjustments suggested that of the total acreage of canola in the western provinces, the proportion in transgenics grew from 15% in 1997 to 66% in 2000.

Table 4.3
Total and Distribution of Acres Harvested by Canola Production System
('000 acres)

	1997	1998	1999	2000
Acres	12,029	13,390	13,743	11,989
Acres <80 acres	289	321	330	288
SMART trait acres	1,684	2,142	2,474	2,434
Net sample acres	10,056	10,926	10,939	9,268
Conventional acres	8,548	6,665	5,032	3,178
Transgenic acres	1,508	4,261	5,907	6,090
SMART trait (%)[1]	14	16	18	20.3
Percent <80 acres[2]	2.4	2.4	2.4	2.4
Percent transgenic[1]	15	39	54	66

[1] Canola Council of Canada, internal reports.

[2] Study Canola Producers Survey of Western Canadian Canola Farmers.

4.2.2.4 Technology Use Agreement

The TUA applies to farmers who have contracted to seed Roundup Ready canola. From the producer survey, approximately 72% of the transgenic seeded acreage, and therefore the population, were seeded using this product. As such, the average cost per acre of the TUA is 72% of the acreage fee of $15.00, or $10.76 per acre.

4.2.2.5 Fixed Costs

No changes in fixed costs between conventional and transgenic systems were quantified or applied in this analysis. It was noted that the transgenic production system supported the trend toward reduced tillage practices. On the surface, this would suggest a lower level of equipment investment and a corresponding reduction in fixed costs. However, the farm survey and case study interviews suggested that the trend toward the adoption of reduced tillage practices were caused primarily by other agronomic and economic considerations. As such, they were not considered in this analysis.

4.3 ECONOMIC MODEL RESULTS

4.3.1 Direct Economic Impacts

4.3.1.1 Per Acre Impacts, Benchmark (2000)

The assessment of the direct economic impacts began with an assessment of the comparative per acre results of revenues and costs between the two canola production systems for the benchmark year 2000. Table 4.4 summarizes the per acre revenues and costs for the two systems, and the difference between the systems.

Table 4.4
Comparative Per Acre Returns, Costs, and Gross Margin, Crop Production Year: 2000

	Transgenic and Conventional Systems			
	Transgenic	**Conventional**	**TG-Conv.**	**Percent**
Yield per acre	29.25	26.54	2.71	10.21
Grade	1.09	1.15	0.02	1.83
Dockage(%)	3.87	5.14	-1.27	-24.71
Effective Farm Price	5.48	5.50	-0.03	-0.45
Revenue	153.95	138.47	15.48	11.18
Costs				
Cost of seed, and application	29.45	22.13	7.33	33.12
Herbicide cost per acre,	13.68	22.53	-8.86	-39.31
Cost of herbicide applications	8.28	7.42	0.86	11.55
Operating cost, tillage	5.95	13.45	-7.50	-55.76
Operating cost, harrowing	3.29	2.94	0.35	11.90
Cost per acre of Nitrogen	18.06	17.07	0.99	5.81
Cost per acre of Phosphorus	6.43	6.13	0.30	4.91
Cost per acre of Potassium	0.81	0.64	0.17	26.76
Cost per acre of Sulphur	2.71	2.47	0.24	9.66
Cost per acre of micro nutrients.	0.14	0.11	0.03	27.27
Cost of fertilizer application	9.10	8.33	0.77	9.24
Consulting cost: weed control services	0.30	0.82	-0.52	-63.41
Technology Use Agreement	10.76	-	10.76	
Crop Scouting costs	1.03	1.10	-0.07	-6.36
Total Direct Costs	**109.99**	**105.14**	**4.85**	**4.61**
Gross Margin	**43.95**	**33.33**	**10.63**	**31.90**

The results from this comparative summary of the 2000 year are as follows:

◊ The gross revenue for the transgenic production system was found to be $153.95 per acre, versus $138.47 for conventional production systems. This equated to a $15.48 per acre, or 11% advantage for the transgenic system. Accounting for the higher revenue was the slightly greater yield and the lower dockage under the transgenic system.

- ◊ Seed and seed application costs were higher for the transgenic by $7.33 per acre, without considering the average TUA costs of $10.76 per acre.
- ◊ An important difference was the higher average herbicide cost for the conventional varieties. This averaged approximately $9.00 per acre or 40% higher than the pesticide costs of the transgenic varieties.
- ◊ Transgenic growers used marginally greater amounts of fertilizers than did the conventional canola growers. Fertilizer costs for the transgenic systems were about $1.72, or 7% higher.
- ◊ The tillage and harrowing costs were significantly different. Conventional varieties had a greater emphasis on tillage and higher costs by nearly 47%. However, harrowing costs were slightly higher for the transgenic system. Overall, the tillage and harrowing costs were about $6.85, or 74% higher for the conventional system.
- ◊ An important cost difference for the transgenic varieties is the TUA costs, estimated to average about $10.76 per acre based on the proportion of producers who used Roundup Ready varieties.
- ◊ On the basis of total relevant direct costs, the transgenic system costs were $110.00 per acre, compared to $105.14 for conventional.
- ◊ On the basis of gross margin (revenue – minus relevant direct costs), the transgenic varieties generated $43.95 per acre, versus $33.33 for the conventional varieties, approximately a $10.62 per acre difference.

4.3.1.2 Multi-Year Per Acre Results

The graphs below present the per acre results over the four year analysis period, 1997 through 2000. As indicated, the revenue and costs, based on the benchmark 2000 year, were projected over the three historical production years.

Figure 4.2 describes the revenue, direct costs, and gross margin over the four year crop production years 1997 to 2000. The revenue has shown a continual drop while direct costs had been relatively constant. This net result is the fairly dramatic fall in gross margin for transgenic production systems from $110.96 per acre in 1997, to $43.95 in 2000, as a result in declining prices for canola.

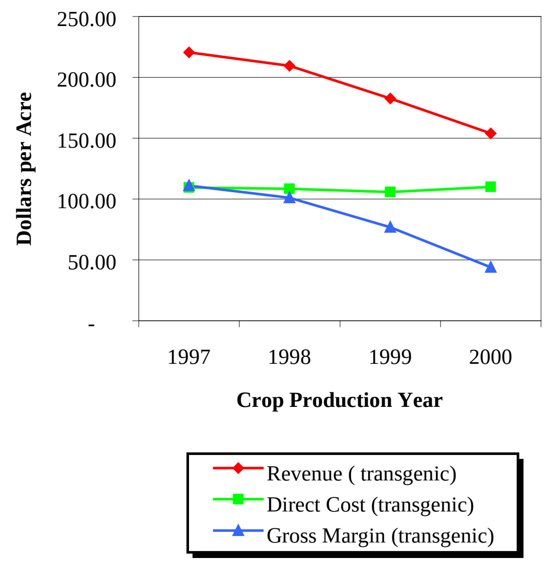


Figure 4.2
Per Acre Results, Transgenic Canola

In a similar fashion, Figure 4.3 shows the decline in revenue and gross margins for the conventional canola varieties. The gross margin for conventional canola declined from $93.24 per acre in 1997 to $33.33 in 2000.

Figure 4.3
Per Acre Results, Conventional Canola Varieties

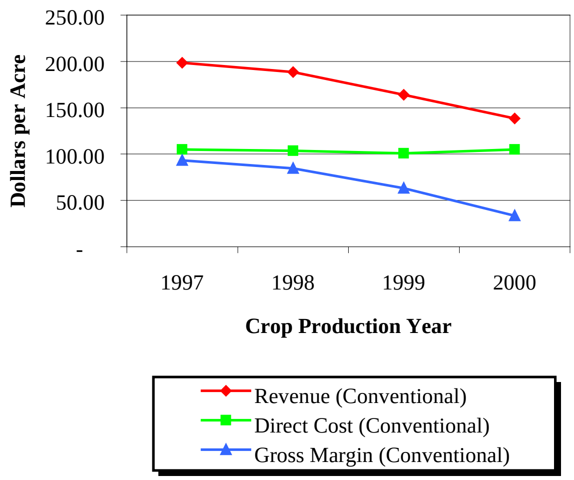


Figure 4.4 recognizes the relative direct economic impacts of transgenic canola. This chart shows the change in the gross margins of the two systems, and plots the differences between the gross margins. Over this four year period, the per acre gross margin of transgenic varieties ranged from nearly $17.72 in 1997, to $10.63 in 2000. This is a first indicator of the relative advantage producers, who have adopted the transgenic production system, have experienced.

Figure 4.4
Gross Margin Analysis

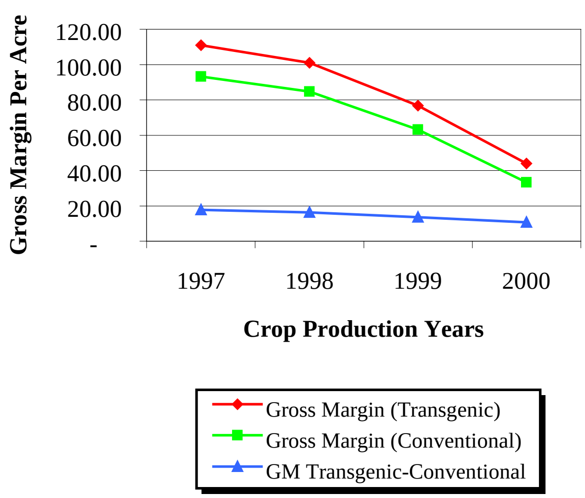


Figure 4.4 also illustrates the fact that the variance in gross margin between transgenic and conventional canolas is narrowing over the period 1997 to 2000. This is due in large part to a decline in canola prices in this time period.

4.3.1.3 Statistical Significance

The gross margins between the transgenic and conventional canola production systems are considered significant.

The table below illustrates the range of expected variability around the mean value of the gross margins for the two production systems.

	Gross Margin	
	Transgenic	**Conventional**
Mean Value	$43.95	$33.33
Margin of Error	+/- 5.5%	+/- 5.5%
Range of Variability	$41.53 to $46.37	$31.50 to $35.16

This table indicates there is no overlap in the expected gross margin results at the limit of the margin of error. These estimates are valid at a 95% level of statistical confidence.

The next section quantifies the aggregate economic impacts of transgenic canola varieties.

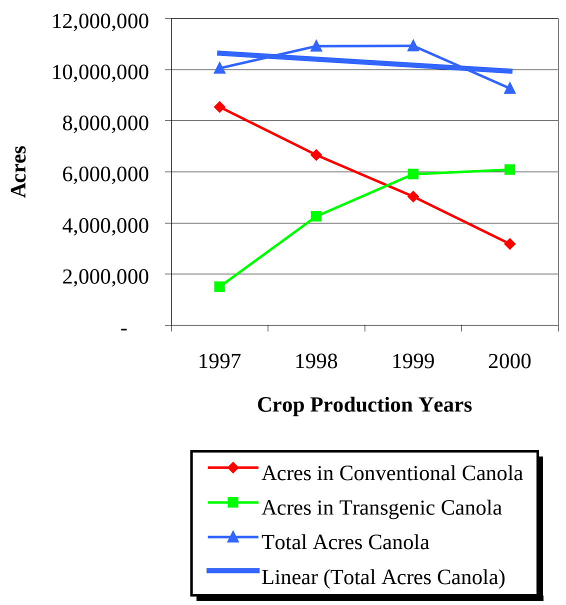
4.3.1.4 Aggregate Direct Impacts

As a first step in understanding the calculation of the aggregate impacts, it is necessary to estimate the number of acres which have been seeded and harvested under the two different systems. Figure 4.5 shows the change in the total number of acres in canola production; the growth in transgenic canola and the decline in conventional canola production.

The acres in transgenic canola production are estimated to have grown from 1.5 million acres in 1997 to 6.6 million acres by 2000. Alternatively, there has been a complete reversal in conventional canola production, from 8.6 million in 1997, to 3.2 million acres in 2000.

The aggregate results are based on the product of the per acre gross margins and the total transgenic or conventional acres.

Figure 4.5
Acres in Transgenic and Conventional Canola



Tables 4.5 and 4.6 show the aggregated results for both transgenic and conventional systems.

Table 4.5
Aggregate Model Results, Transgenic Canola
('000)

	1997	1998	1999	2000
Area seeded in canola	1,508	4,261	5,907	6,090
Acres in summer fallow	231	652	904	932
Canola revenue ($)	332,692	892,642	1,078,325	937,485
Costs				
Seed cost	43,929	126,798	172,266	179,360
Chemical costs	31,811	92,307	128,063	133,712
Fertilizer costs	57,380	152,154	198,369	226,851
Tillage costs	13,846	39,336	54,800	56,269
Weed consulting costs	443	1,252	1,737	1,827
Technology Use Agreement	16,291	46,021	63,799	65,525
Crop scouting costs	1,617	4,414	5,936	6,272
Total Direct Costs	165,315	462,283	624,970	669,816
Gross Margin	167,377	430,359	453,355	267,669

Table 4.6
Aggregate Model Results, Conventional Canola
('000)

	1997	1998	1999	2000
Area seeded in canola	8,548	6,665	5,032	3,178
Acres in summer allow	2,393	1,866	1,409	890
Canola Revenue ($)	1,695,697	1,255,799	826,212	440,070
Costs				
Seed cost	187,001	148,985	110,237	70,319
Chemical costs	251,033	197,930	148,399	95,208
Fertilizer costs	303,276	221,932	157,552	110,439
Tillage costs	140,310	109,262	82,402	52,090
Weed consulting costs	7,295	5,497	4,026	2,606
Crop Scouting Costs	9,786	7,374	5,400	3,496
Total Direct Costs	898,700	690,980	508,017	334,157
Gross Margin	796,997	564,819	318,196	105,913

Based on the results of the above two tables, several measures of the economic impacts of transgenic canola varieties are explained and estimated.

4.3.1.5 Direct Aggregate Economic Impact

The first and most important variable is developing an overall assessment of the direct economic impact of transgenic canola. The measurement of net economic benefit is defined as the net difference in gross margin per acre between transgenic and conventional varieties, applied to the number of acres in transgenic canola production on a year-by-year basis.

Aggregate economic impact = difference in gross margin per acre x number of acres in transgenic production

For example, the unit gross margin in 1997 was $110.96 and $93.24 per acre for transgenic and conventional systems, respectively, a difference to the advantage of transgenic of $17.72 per acre. In that year, an estimated 1.51 million acres were in transgenic production. This resulted in a deemed $26.7 million net direct impact of transgenic canola on the western Canadian canola industry ($17.72 times 1.51 million acres).

It is important to note that the economic impact cannot be defined as simply the difference in the aggregate gross margin between the two systems.

Figure 4.6 summarizes the calculations of the direct economic impacts. The direct annual and cumulative impacts are shown in 2000 year dollars by using the rate of input price inflation as a factor.

Figure 4.6
Annual and Cumulative Economic Impacts of Transgenic Canola

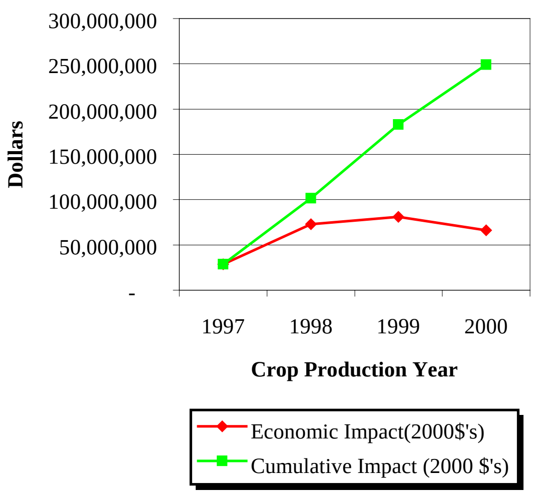


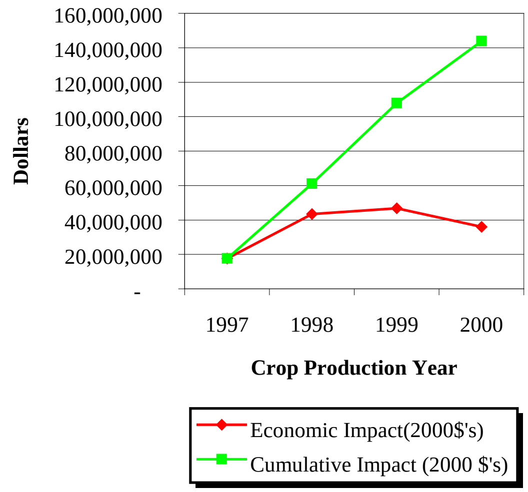
Figure 4.6 shows the annual economic impact of transgenic canola production systems to range from $29.0 to $81.0 million. On a cumulative basis, the net direct benefit of this production system is estimated to have generated a benefit of $249.0 million to the industry over these four years, expressed in 2000 dollars. It is noted that the annual economic impact has declined in 2000.

In addition to the direct economic impact based on the calculated results of the producer survey, an additional estimate of impact has been developed based on the farmers own estimate of net income for transgenic and conventional production systems. The farmers estimated, based on the direct survey question, that transgenic production systems provided them a $5.80 per acre net income advantage over their conventional canola production system.

The industry economic model was re-run using this farmer estimated $5.80 net income difference per acre in 2000. All revenue and cost assumptions were maintained for the previous years as in the original model calculations.

Figure 4.7 summarizes these calculations.

Figure 4.7
Direct Economic Impact, Producer Survey Estimate



Using producer estimates of net income, the annual impact was found to vary from $18.0 million to $47.0 million over this four year analysis period. The cumulative direct economic impact, using the farmers own estimates, totalled $144.0 million over this period, expressed in 2000 dollars.

In summary, the calculated total direct economic impact over the four years is estimated at $249.0 million. The producer based estimate accumulates to $144.0 million.

A principal result of this analysis is that the direct economic impact of the adoption of transgenic canola production systems is within the range of $144.0 and $249.0 million, presented in 2000 dollars.

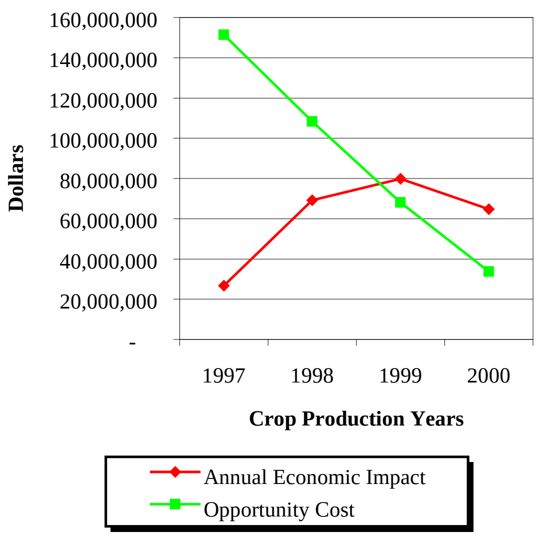
4.3.1.6 Opportunity Cost Impact

An additional evaluation of the opportunity cost experienced by the industry was completed. A possible opportunity cost may exist given the following: a) there is a net economic benefit of this technology, and b) a number of farmers have not adopted this technology.

Therefore, the potential opportunity cost is defined as the per acre net impact of transgenic canola, applied to the number of acres which did not use transgenic canola.

Figure 4.8 shows the opportunity cost to the industry of not having fully adopted transgenic canola. Also included on this chart is the annual economic impact, repeated from the previous chart.

Figure 4.8
Opportunity Costs of Transgenic Canola



The opportunity cost was of course high at the beginning of the analysis period, estimated at $151.0 million in 1997, when only about 15% of the farmers had adopted transgenic canola production systems. By 2000, this opportunity cost had declined to $34.0 million, as nearly 66% of the farmers have now adopted this system.

4.3.1.7 Summer Fallow Opportunity Costs

A further important economic impact for evaluation relates to the relative emphasis on summer fallow practices between transgenic and conventional canola. Of total land typically in canola production, 13% was retained in summer fallow under the transgenic system. For conventional canola production, about 22% was summer fallowed.

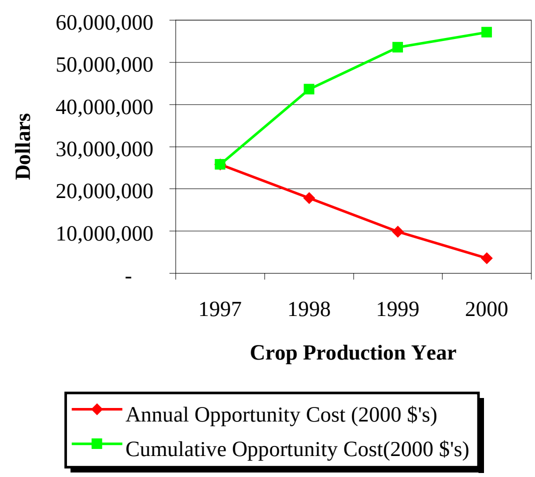
This lesser use of summer fallow, and greater emphasis on reduced tillage practices under transgenic canola production is a potential benefit of this system. Alternatively, there is an opportunity cost to conventional canola production, in that additional acres are tied up in summer fallow, versus crop production.

This opportunity cost has been estimated, based on the incremental difference in acres in summer fallow between transgenic and conventional canola. The added acres are a lost opportunity for production. The net opportunity cost is the net difference in acres, times the gross margin per acre of transgenic canola, times the total acres under summer fallow in conventional canola. Table 4.7 and Figure 4.9 provide the results.

Table 4.7
Summer Fallow Opportunity Costs

	1997	1998	1999	2000
Gross Margin per acre, Transgenic	110.96	100.00	76.45	43.95
Difference per acre in Summer Fallow (C-T)	0.090	0.090	0.090	0.090
Per acre Summer Fallow Opportunity cost	9.99	9.09	6.91	3.96
Acres Summer Fallow, Conventional (m)	2.4	1.9	1.4	0.9
Opportunity Cost ($ m)	25.9	17.9	9.9	3.6
Cumulative Opp. Cost ($ m)	25.9	43.8	53.7	57.3

Figure 4.9
Summer Fallow Opportunity Costs



The annual opportunity cost of summer fallow falls from $26.0 million in 1997 to $4.0 million in 2000. Values are expressed in 2000 dollars. The cumulative opportunity cost is estimated to be $57.3 million over this four year period.

4.4 Environmental Impacts

The environmental impacts have been considered in this analysis. The primary approach was to quantify the relative use of physical inputs such as herbicides, fertilizer, and energy between transgenic and conventional canola production. The results of this analysis are described below.

4.4.1 Herbicide Use

The two production systems exhibited significantly different practices with respect to the use of herbicides. From a general environmental perspective, the lower use of herbicides would be considered positively contributing to environmental welfare. This does not bring into consideration toxicity or residue levels.

The total quantities of herbicides has been determined. The survey information provided the unit quantities of chemical used for herbicide application. The specific per acre quantities used have been aggregated over the total acres in transgenic and conventional canola production, and a comparative use of chemical was estimated.

Figure 4.10 and Figure 4.11 show the relative use of herbicides between the two systems.

Figure 4.10 traces the quantities of herbicides used. The total use over this period varied from over 24,000 tonnes in 1997, to about 17,000 tonnes in 2000. The change in use between the two systems reflects the relative number of acres devoted respectively to the two systems.

Figure 4.11 allows a quantification of the potential environmental impacts as related to herbicide use. The chart first shows the total amount of consumption for two scenarios: a) if all the acres would have used herbicides at the conventional rate per acre; and b) if all acres under production would have used herbicides at the transgenic herbicide rate.

Figure 4.10
Relative Use of Herbicides (tonnes)

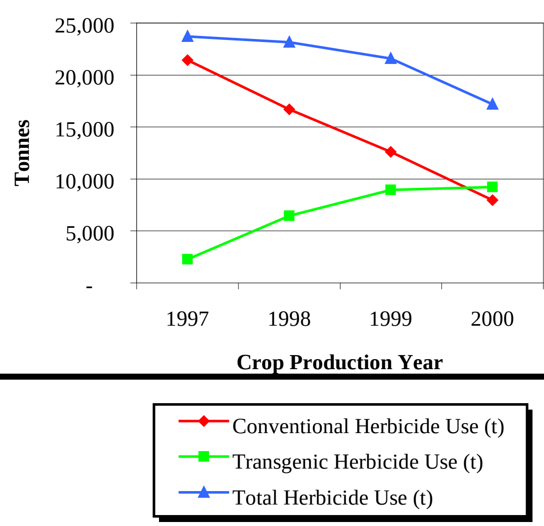
As shown, the total use of herbicides would have been lower if all land had been in transgenic canola. The actual amount is shown on this same chart as the potential gain. This gain is expressed in negative values to reflect the potential reduction in pesticide consumption. It shows the potential reduction in herbicides averages about 10,000 tonnes per year.

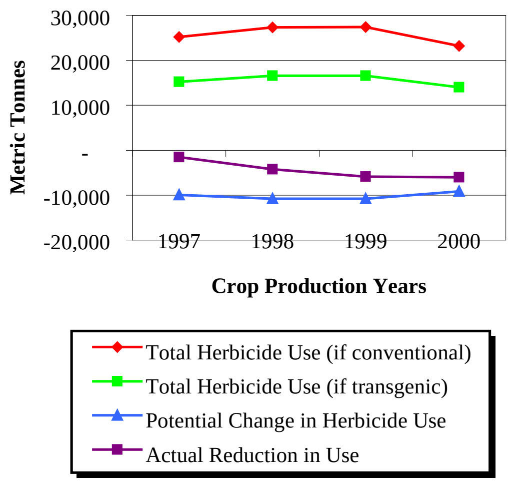
Figure 4.11 shows the actual reduction in the use of herbicides due to the adoption of transgenic canola. This was based on the reduced use of chemical over the number of acres in transgenic canola production. The actual reduction in the use of herbicides varies from 1,500 tonnes in 1997, to about 6,000 tonnes in each of 1999 and 2000.

Overall, the impact of the adoption of transgenic canola production has contributed significantly to the reduction of chemical herbicide usage.

No conclusion is made on the specific environmental impact of this reduced herbicide use.

Figure 4.11
Transgenic Canola Impact on Herbicide Consumption





4.4.2 Fertilizer Use

The use of chemical fertilizers was estimated for each of the canola production systems.

The costs of fertilizer use between the two production systems were $28.15 and $26.43 per acre for transgenic and conventional, respectively. These values are not significant. Further, if the higher proportion of summer fallow areas is considered in the conventional system, fertilizer usage is almost identical between transgenic and conventional.

4.4.3 Fuel Consumption

A determination of the difference in fuel consumption was made between transgenic and conventional canola production. Overall, there were added operating costs for conventional canola production due to the greater emphasis on tillage and herbicide applications. From the per acre unit analysis, the net difference in operating costs for all tillage, harrowing, fertilizer, and chemical herbicide applications was determined. This information was then used to determine differences in fuel consumption as listed in Table 4.8.

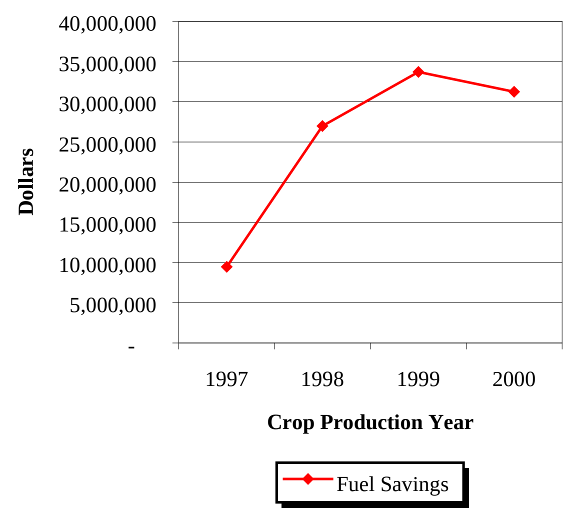
From the added operating costs of conventional production systems, the proportion of fuel cost was estimated, and from this, the number of litres this cost represented.
The estimate of fuel savings was determined by the product of the fuel saving per acre used by transgenic canola production system, and the number of acres under transgenic production in each of the four analysis years. Fuel price is indexed from the 2000.

Table 4.8
Fuel Savings – Transgenic Canola

	1997	1998	1999	2000
Change in Operating Costs (Conv-Trans)	$6.21	$5.68	$5.41	$5.52
Percent Fuel Costs as Percent of Operating Cost	0.39	0.39	0.39	0.39
Added Fuel Cost Per Acre	$2.42	$2.22	$2.11	$2.15
Fuel Cost Per Litre	$0.385	$0.35	$0.37	$0.42
Quantity Fuel Per Acre Change (L)	6.3	6.3	5.7	5.1
Fuel Saving (Million Litres)	9.5	27.0	33.7	31.2

The net result of this analysis shows that the added fuel consumption on conventional production systems averaged between 5.1 and 6.3 litres per acre. The aggregate impact of this has been significant, varying from a saving of 9.5 million litres in 1997, to 31.2 million litres in 2000. This fuel saving is shown in Figure 4.12 below.

Figure 4.12
Fuel Savings for Transgenic Canola

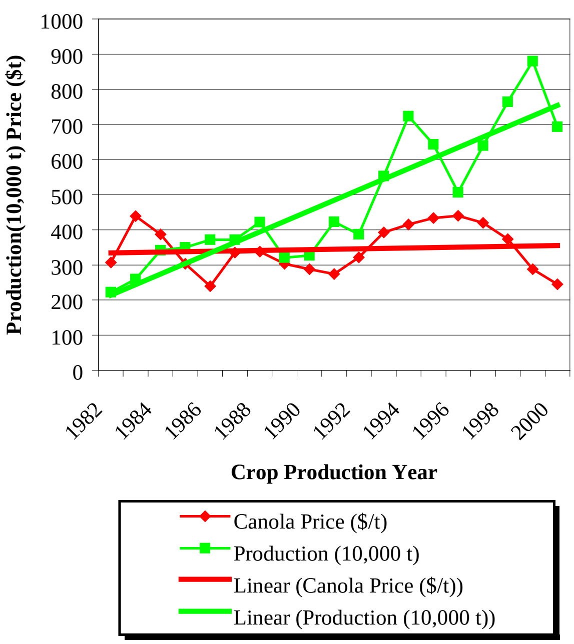


4.4.4 Transgenic Canola's Impact On Canola Prices

An important consideration is the potential impact that transgenic canola production may have had on canola market prices. Theoretically, if transgenic canola has resulted in a significant increase in production, this could have a negative impact on prices. This is dependent on the amount of the increase, the degree of causality between Canadian production and canola prices, and the potential that other factors may be influencing the change in canola prices.

First, the trends in canola prices and total Canadian production have been traced over the period 1982 to 2000 as shown in Figure 4.13. Trend lines have been statistically placed on these variables to better understand how they have moved over time. It is important to note that the production trends have been consistently growing since the beginning of this period. At the same time, the trend line for canola prices has been essentially flat over this period.

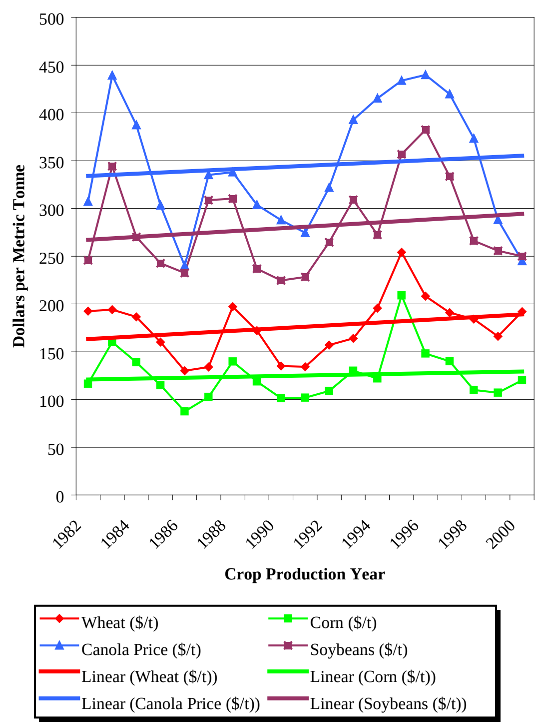
Figure 4.13
Canola Prices and Production, 1982-2000



Source: AAFC, Strategic Policy Branch, Market Analysis Division, Winnipeg, Nov. 27.

This analysis was extended further through comparing the movement of other commodity prices over this same period. The average prices and trend lines for wheat, corn, canola, and soybeans are shown in Figure 4.14. There have been very similar trends in these commodity prices over this period. In particular, the pattern of soybean and canola prices appear to be the most comparable over this period.

Figure 4.14
Trends in Selected Commodity Prices, 1982-2000



To further examine the relationships between these commodity prices and canola, correlation coefficients were calculated. Such correlations depict which variables have trended together most closely. A high correlation coefficient however does not indicate causality.

Table 4.9 indicates the correlations between these commodity prices, concluding that soybean and canola prices have trended together most closely over this period. The correlation coefficient is .84 or 84%. Perfect correlation would be indicated by a factor of 1.0 or 100%.

Table 4.9
Commodity Price Correlations

	Wheat Price	Corn Price	Canola Price	Soybean Price

Wheat Price	1.00	0.88	0.65	0.64
Corn Price		1.00	0.74	0.77
Canola Price			1.00	0.84
Soybean Price				1.00

However, these correlations do not directly answer the question: did the increased production over the past years result in the recent fall in canola prices, and by extension, has the adoption of transgenic canola production resulted in this price impact?

To answer this, a regression analysis was conducted between canola prices, and canola production.

The results of this regression show no significant causality between the level of canola production, and price. The details of the regression are:

Dependant Variable: Canola price, dollars per tonne

Independent variable: canola production, tonnes per hectare

Multiple R squared:	.162
Adjusted R squared:	-.031
T value:	.67
F value:	.46
Standard error:	67.39

These results clearly show that there is almost no relationship or causality between the level of production, and the price of canola. In addition to the very low R squared, the T and F values were not significant. These values would have to exceed 1.73 and 4.45 for the T and F value respectively, to be significant. As previously indicated, there was a close correlation between other commodity prices such as soybeans. Canola prices appear to be more influenced by other commodity prices.

In addition, a regression was completed between canola and soybean prices. In this case, the regression showed a high R-squared (.83), and significant T and F tests (in excess of the threshold values of 1.73 and 4.45 for the T and F values respectively).

Overall, the price of canola appears to be established within the context of the international markets of corn, soybeans, and other oilseeds versus being more influenced by the level of Canadian production.

4.4.5 Long Term Impacts of Transgenic Canola on Prices and Exports

Significant issues exist with respect to consumer attitudes toward Genetically Modified (GM) commodities and foods. In particular, the European Community (EU) has not approved the importation of Canadian and U.S. genetically modified canola. Minimal efforts are underway to segregate the production, shipping, storage, and marketing of GM and non-GM canola, both in the United States and Canada.

Countries like Australia have not gone forward as fast as Canada and the U.S. into genetically modified food crops[4]. This has led to at least isolated sales into the European community, destined to oilseed crushing plants in Europe.[5]

Markets now indicate that on a limited basis, a non-GM premium has appeared in the marketplace. As reported in the *Australian*, up to US $5.00 per tonne premium was received for a shipment of non-GM canola.[6]

Considerable uncertainty exists as to the degree and duration of consumer and market resistance to transgenic canola. It is possible that there could be some price impacts and the closing of some markets, at least in the short run for transgenic canola.

A full economic assessment of this impact is considered impossible given the political controversy around this issue.

4.5 SECONDARY AND MULTIPLIER IMPACTS

Another consideration the adoption of a new technology such as transgenic canola production systems may have, is the impact on the rural or larger communities in western Canada. Typically, any change in direct economic activity creates indirect and induced impacts in the surrounding region.

In the case of transgenic canola production, there have been economic gains at the producer level. This

[4] Australia Non-GM Grains Cash in Winning Trade Hand, Australia, August 12,2000.
[5] Asia Pulse via COMTEX, Australia's Non-Genetically Manipulated Canola Oil Dominates the European Market, Jan 8,1999.
[6] Ibid., Non-GM Grains Cash in Winning Trade Hand.

has been previously defined as the net change in gross margin attributable to the adoption of transgenic canola. Examples of potential indirect and induced impacts of this technology could be as follows:

- ◊ the added investment in additional processing plant capacity for the added canola supply;
- ◊ local industry investment and development in added infrastructure for input supplies of seed, pesticides, fertilizers, equipment, consulting services, etc.;
- ◊ added shipping, handling, processing, and marketing facilities;
- ◊ the potential impact on training, education, and information services; and,
- ◊ the attraction of new secondary industry investment.

Secondary impacts are generally defined in terms of added investment, income, and employment which the direct impact has initiated. The measurement tool is usually expressed as a multiplier, applied to the level of direct impact. These multipliers are determined on the basis of regional or provincial input-output models. Multipliers generally vary from just over one, to as high at four for some industries. A multiplier of 1.5 for example, suggests that the total impact of an industry is 1.5 times the direct economic impact. If the direct impact of an industry is $1,000.00, the total impact at all levels in the economy, including the direct impact, is therefore $1,500.00.

For the purpose of estimating the multipliers which may apply to adoption of transgenic canola, secondary research has led to the estimation of conservative indicators. One study, conducted by Ernst & Young, on the biotechnology industry in the United States[7] produced a number of multiplier estimates for this industry. These were an employment multiplier of 2.9, an income multiplier of 2.3, and a personal income multiplier of 2.0.

An additional study conducted at Purdue University[8] measured the impact of agriculture and other industries in Indiana. The agriculture output multipliers varied from a low of 1.5 to a high of 2.2 for the agricultural industry.

For purposes of measuring the secondary impacts of transgenic canola technologies, a range of multipliers were selected and applied to the net economic gains or direct impacts. It was considered that a reasonable and conservative range is of a lower limit of 1.25, to a higher limit of 1.9. The total impact of this technology is shown in Table 4.10. In addition, Figures 4.15 and 4.16 depict the direct economic impacts and the total cumulative impacts using these multipliers, at the lower and upper levels.

Table 4.10
Economic Multipliers

	1997	1998	1999	2000
Net Economic Gain (m)	26.7	69.2	79.8	64.7
Lower Limit Economic Multiplier	1.25	1.25	1.25	1.25
Upper Limit Economic Multiplier	1.9	1.9	1.9	1.9
Total Economic Impact(low) ($ m)	33.4	86.6	99.8	80.9
Total Economic Impact (high) ($ m)	50.8	131.6	151.7	123.0

Figure 4.16 summarizes the cumulative total economic impact of transgenic canola production systems. The direct impacts accumulate to $240.5 million by 2000. Including the indirect impacts, the accumulated economic benefit is estimated to be between $300.0 and $457.0 million.

Figure 4.15
Multiplier Impacts of Transgenic Canola

[7] Ernst & Young Economic Consultants and Quantitative Analysis, The Economic Contributions of the Biotechnology Industry on the US Economy, May 2000.
[8] David Broomhall, The Use of Multipliers in Economic Impact Estimates, Community Development, Purdue University, Cooperative Extension Service, EC-686.

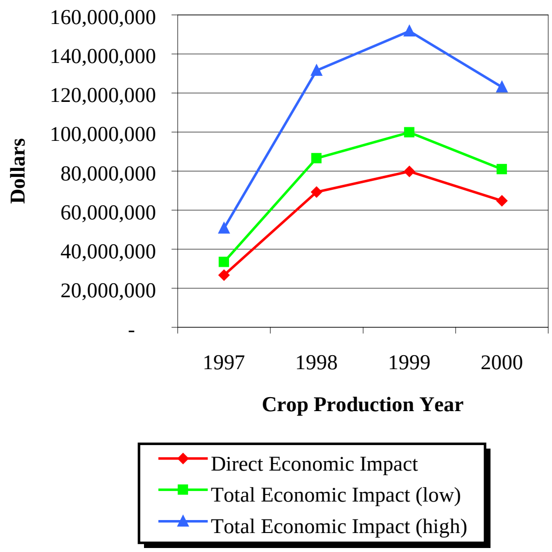
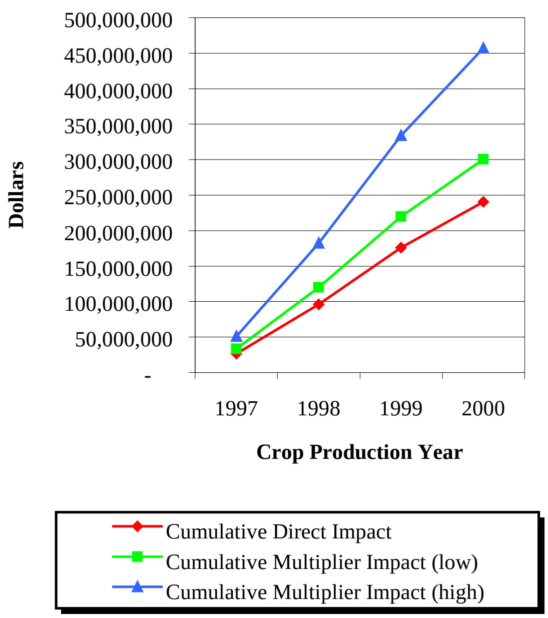


Figure 4.16
Cumulative Direct and Secondary Impacts of



Transgenic Canola

4.6 Economic Analysis Summary and Conclusions

The analysis provided an economic assessment of the adoption of transgenic production systems by Canadian farmers in the western provinces of Alberta, Saskatchewan, and Manitoba. The primary source of data for the economic assessment was from the producer survey of 650 farmers in the fall of 2000. This base information was supplemented by 13 detailed case studies in these three provinces, along with secondary research.

The economic assessment covered the four recent crop years, 1997 through 2000, in which there had been a significant adoption of this new canola production system. Farm level per acre revenue and costs were estimated for the transgenic and conventional systems.

The economic assessment measured the direct and indirect impacts of this technology. Direct impacts are those economic effects on the agricultural producer. Indirect effects include the other impacts which may have resulted from the direct impacts, on the regional economy. The essential results are summarized below.

4.6.1 Direct Economic Impacts

4.6.1.1 Per Acre Impacts

The direct economic impact of transgenic canola is measured on the basis of the differential in the gross margin between the two canola production systems. The gross margin is defined as revenue, less the direct costs of agronomic practices which are different between the two systems. Specifically, agronomic practices such as seeding, tillage, herbicide, and fertilizer management represent the most important possible sources of differences between the two systems. Other costs of production are not considered, and as such, the gross margin as used in this analysis is not comparable to that used in standard farm enterprise analysis.

The analysis determined a significant difference between the gross margins for the two systems over the four year analysis period. This difference amounted to $10.62 higher for the transgenic system over the conventional, a 30% advantage in 2000.

The primary reasons for this advantage related to both changes in revenue and cost between the two systems. Revenue of the transgenic system was $15.48 dollar per acre higher in 2000, due to a higher yield and a lower level of dockage.

The direct costs were higher for the transgenic system by $4.86 per acre. The TUA, fertilizer, and seed costs were the major contributors to these higher costs. Other individual costs factors, such as herbicide and tillage cost were lower for transgenic canola. The most significant cost difference was the much lower herbicide cost, of approximately $9.00 per acre.

During the study period, the gross margin narrowed between the two systems. In 1997, the transgenic gross margin was $17.72 higher, falling to $16.26 in 1998, $13.51 in 1999, and $10.62 in 2000, mainly as a result of declining canola prices.

4.6.2 Aggregate Impacts

The aggregate impact of the adoption of transgenic canola production was measured by the net gain in gross margin of transgenics over the acreage harvested under the production system.

The number of transgenic acres increased from approximately 1.5 million acres in 1997 to 6.1 million acres in 2000.

Applying the per acre higher gross margin for transgenics to these acres is a measure of the economic impact. Expressing this annual impact in 2000 dollars resulted in $28.8 million in 1997, up to $72.9 and $81.2 million in 1998 and 1999 respectively, and then down to $66.0 million in 2000.

The cumulative net impact of this adoption is estimated at $249.0 million over this four year period.

4.6.3 Opportunity Costs

4.6.3.1 Opportunity Cost of Growing Conventional Canola

Another method of assessing the impact of the adoption of a new technology is to measure the cost of not adopting it. In this case, a cost can be attributed to the land which remained in conventional canola production systems.

This approach to estimating these costs resulted in an opportunity cost of $151 million in 1997 when most of the acres were still under the conventional system. This opportunity cost dropped to $33.8 million by 2000.

4.6.3.2 Summer Fallow Opportunity Costs

The transgenic production system resulted in a greater use of reduced tillage practices and lesser acres in summer fallow. The opportunity cost of summer fallow is not being able to seed it in productive crops.

The opportunity cost has been calculated, based on the difference in acres of summer fallow, times the gross margin per acre of transgenics, times the number of conventional summer fallow acres.

The analysis found that the opportunity cost of these added acres in fallow varied from a high of $27.5 million in 1997, to a low of $3.6 million by 2000.

4.7 INDIRECT AND INDUCED IMPACTS

4.7.1 Multiplier Impacts

An important factor to measure is the direct impacts the technology change may have on the region and community. These impacts can include added investment in processing capacity, new infrastructure, and other investment.

A range of multipliers were applied to give an indication of these impacts. The multipliers were applied to the net direct aggregate impact. This range of impact was from $33.0 to $51.0 million in 1997. This increased to a range of between $87.0 and $132.0 million in 1998, and $100.0 and $152.0 million in 1999. The impact fell off in 2000 to between $81.0 and $123.0 million. It is important to note that the multiplier impact included the direct impacts.

4.7.2 Total Economic Impacts

The total economic impacts due to the adoption of transgenic production systems included the direct and indirect impacts, accumulated over the four year analysis period.
The table below summarizes these impacts.

Table 4.11
Accumulative Economic Impacts of Transgenic Canola Production Systems
All values in Millions of Dollars

Economic Impact	Nominal Value Lower Level	Nominal Value Upper Level	Value in 2000$'s Lower Level	Value in 2000$'s Upper Level
Direct	240.5	240.5	249.0	249.0
Indirect	60.2	215.5	57.7	214.9
Total	300.7	456.0	306.7	463.9
Producer Estimated Direct Impact	144	144	144	144

Comparing these calculated direct benefits to the producer survey estimate of $144.0 million net benefit, provided a range of direct impacts of between $144.0 and $249.0 million.

4.7.3 Impacts On Canola Prices

One possible impact that the adoption of transgenic production systems could have is on price. If the transgenic system encourages added production, in a limited market, this could lead to a drop in prices, and potentially a reduction in producer returns.

To evaluate this possible impact, a statistical analysis was conducted on canola prices, production, and on the movement of other similar commodities, such as wheat, corn, and soybeans.

As a result of this analysis, no statistical correlation, or causality could be found that would lead to the conclusion that this technology adoption has led to a drop in prices.

It was found that canola prices are linked very closely to other commodity prices, in particular soybeans.

In the future however, there may be other external impacts on the price and use of transgenic canola. There are certain markets, led by the EU, who are restricting the importation of genetically modified products such as canola.

The future impacts of these trends cannot be fully evaluated at this time.

4.8 Environmental And Resource Use Results

The potential environmental impacts of the adoption of transgenic canola production systems have been investigated from the perspective of resource consumption. This approach made the assumption that a higher level of use of certain inputs such as chemical herbicides, chemical fertilizers, and fossil fuels, were potentially more harmful to the environment.

The use of these key production inputs were evaluated.

4.8.1 Herbicide Use

It was found that under the transgenic system, less quantities of herbicides were used per acre than with the conventional system. Given the lesser use per acre, the amount of total reduction in herbicide use was determined by the product of this unit savings, and the number of acres in the transgenic system. It was found that 1,500 tonnes of herbicide were saved in 1997, increasing to 6,000 tonnes per year by 2000.

The potential opportunity savings, assuming that all the canola acreage would have been under transgenic production, would have resulted in an annual reduction in herbicide use of between 9,000 and 11,000 tonnes per year.

4.8.2 Fertilizer Use

There was found to be no significant change in fertilizer due to the adoption of the transgenic system.

4.8.3 Fuel Savings

The more extensive tillage and herbicide applications for conventional canola systems of production leads to the greater use of fossil fuels, deemed a negative factor for the management of the environment.

The amount of added fuel use was estimated between 5 and 6 litres per acre more for conventional over transgenic canola. The total amount of fuel savings was estimated by applying this per acre savings over the number of transgenic canola acres in production. The amount of fuel savings ranged from 9.5 million litres in 1997, to 31.2 million litres in 2000.

In summary, the transgenic canola production systems, have in this analysis period, contributed significantly to the reduction in the use of chemical herbicides and fossil fuels.

5.0 SUMMARY AND CONCLUSIONS

The objective of this study was to "qualify and quantify the agronomic and economic benefits associated with transgenic canola to better understand the impact it has had on agriculture in western Canada". The study included an analysis of an extensive producer survey, thirteen case studies in various production areas of western Canada, and an integrated industry economic model. The outcome of these analyses and the determined impacts are included in the following summary discussion of agronomics, economics, and environmental and social aspects.

5.1 AGRONOMICS

Generally, the perception among case study and survey participants was that transgenic canola yields higher than conventional varieties. Survey results showed that transgenic canola yielded approximately three bushels per acre (>10%) more than conventional canola in 2000. Case study participants reported a very similar yield advantage for transgenic canola. The yield advantage for transgenic systems resulted from the varieties and a slight increased use of fertilizer, but less summer fallow. Dockage was significantly lower in the transgenic system, largely attributed to more effective weed control. There was no statistically significant difference in grade between the two systems.

The literature search was not as conclusive as the survey and case study information with respect to yield. Several articles state that there was a significant yield drag with transgenic soybean varieties, and cite university studies, as well as U.S. and European trials as evidence of this. However, other articles reported the opposite, that higher yields are possible with transgenic crops and cited trials and farmer surveys which backed up their conclusions.

Interestingly, surveyed growers reported more efficient weed control as one of the key benefits and motivators to adopt transgenics, in addition to the cost benefits illustrated by the economic analysis derived from this research. Importantly, growers reported an improvement in weed control effectiveness and the ease of herbicide management to prevent weed resistance. Yield is impacted by several factors: earlier seeding, more effective and earlier weed control; the ability to utilize higher yielding *B. napus* varieties, decreased petal blast, better moisture availability, and earlier harvesting. The first three stages of this study (literature search, survey and case studies) reported that these factors have been the primary drivers in the switching to transgenic canola.

Transgenic canola growers reported having made fewer tillage passes over their fields than growers of conventional varieties. The majority of the transgenic sample in both the survey and the case studies indicated they practice minimum or zero till on their operations. Conventional growers are more likely to utilize summer fallow in their rotations; 36% of the conventional sample had summer fallow acres in 1999 as compared to only 18% of the transgenic sample. Transgenic growers found that their rotations were more flexible, and they were able to seed earlier in the spring, or in the fall, thus benefiting from soil moisture conservation. Importantly, 2.6 million acres in canola rotations in western Canada have been positively impacted by increased conservation tillage practices since the introduction of the technology. Canola acres overall have increased significantly since the introduction of transgenics five years ago.

Clearly, the majority of growers surveyed believed that there are significant advantages to transgenic canola. Participants in the survey and in the case studies stated that their primary reason for adopting transgenic canola were not economic, but agronomic. The transgenic system is simple, the weed control is early and effective, and the system fits well into a reduced or no-till operation.

5.2 ECONOMIC ANALYSIS

Information from the secondary research review, extensive producer survey, and specific case studies culminated in the economic analysis. The economic modelling approach estimated changes in economic activity resulting from the production of transgenic and conventional canola varieties. These changes were expressed in terms of direct impact (combined impacts on revenues and operating costs related to changes in agronomic practices) and induced and indirect effects (the consequence of backward linkages to suppliers and subsequent spending within the community). Direct effects were assessed based on the value of canola production at the producer and aggregated level, based on estimated devoted acreage at the national level.

Multipliers were applied to changes in output and revenue streams to estimate the secondary, indirect, and induced effects. Estimates for these multipliers were derived from studies conducted on the biotechnology industry in the United States. In addition to the direct and indirect/induced effects resulting from the changes in production activity, the analysis assessed market responses.

5.2.1 Direct Effects

The enterprise budget modelling approach estimated farm revenue and costs of production for the producer and national level for a four crop year period (1997 through 2000). To statistically control for factors relevant to the model, indices for product price, yield, and select input prices for 1997, 1998, and 1999 were based on the 2000 benchmark year. A summary of the enterprise and aggregate budgets from transgenic and conventional systems is presented in Table 5.1.

The variance in gross margin between transgenic and conventional canola systems reflected the direct impact of transgenic canola adoption over the period under review. The aggregate economic impact was estimated based on the difference in gross margin per acre between transgenic and conventional canola varieties and adjusted for the number of acres devoted to transgenic production.

The direct economic impacts are estimated from the detailed model and the producer survey estimates.

Table 5.1
Producer Per Acre Estimates

	1997		1998		1999		2000	
	Trans.	Conv.	Trans.	Conv.	Trans.	Conv.	Trans.	Conv.
Yield (bu)	27	24	29	26	33	30	29	27
Revenue ($)	244.40	219.02	232.13	208.60	202.28	181.77	154.65	138.97
Direct Costs ($)	115.68	106.94	114.15	105.35	111.06	102.51	116.03	106.91
Gross Margin ($)	128.72	112.69	117.98	103.25	91.22	79.26	38.62	32.06

Table 5.2
Direct Economic Impact

	1997	1998	1999	2000
Gross Margin ($) (model)	26,730,475	69,245,330	79,821,330	64,728,779
Gross Margin ($) (producer estimate.)	17,570,000	43,433,000	46,801,000	36,047,000

*The added Gross Margin on the acres devoted to transgenic canola production.

5.2.2 Indirect and Induced Effects

Secondary impacts to the surrounding communities and businesses resulting from added investment, income, and employment generated by the production of canola were estimated with the application of multipliers. A range of multipliers (lower and upper limits) were applied to the net direct aggregate impact to estimate the total economic effect (inclusive of direct effects). The results from this analysis were as follows:

Economic Multipliers

	1997	1998	1999	2000
Net Economic Gain ($ m)	26.7	69.2	79.8	64.7
Lower Limits Economic Multiplier	1.25	1.25	1.25	1.25
Upper Limits Economic Multiplier	1.9	1.9	1.9	1.9
Total Economic Impact (low) ($ m)	33.4	96.6	99.8	80.9
Total Economic Impact (high) ($ m)	50.8	131.6	151.7	123.0

5.2.3 Summary of Economic Impacts

The table below summarizes the cumulative economic impacts of transgenic canola production systems on western Canadian farms. The direct impacts based on the detailed model calculation is estimated at $249.0 million in 2000 dollars. The farmers net income based estimate of direct impact is $144.0 million. The indirect impact in 2000 dollars is estimated to range between $58.0 and $215.0 million, using the lower and upper multiplier, respectively.

In summary, the total economic impact of transgenic canola production systems has been estimated to be up to $464.0 million over the period 1997 to 2000, inclusive of direct and indirect impacts.

Accumulative Economic Impacts of Transgenic Canola Production Systems

All values in Millions of Dollars

	Nominal Value		Value in 2000$'s	
Economic Impact	Lower Limit	Upper Limit	Lower Limit	Upper Limit
Direct	240.5	240.5	249.0	249.0
Indirect	60.2	215.5	57.7	214.9
Total	300.7	456.0	306.7	463.9
Producer Estimated Direct Impact	144	144	144	144

5.2.4 Market Responses

Based on an econometric analysis, no causal relationship is evident between canola production and price (1982 through 2000). Canola price series did demonstrate strong positive relationships with that of other commodity prices (in particular, soybeans). There was no evidence to support the hypothesis that adoption of transgenic varieties had a negative impact on canola prices or producer returns.

Although economic and agronomic benefits are significant, some uncertainty exists in the future with respect to the marketing of genetically modified crops such as canola. Markets to Europe have been closed to genetically modified canola from North America.

Considerable uncertainty exists as to what will be the degree and duration of consumer and market resistance to transgenic canola. In the meantime, there is a need to establish identification protocols within the grains and oilseeds handling systems.

5.3 Environmental And Social Aspects

A review of published articles and studies revealed that the most expressed concern was the inability to control the increase in number and the spread of herbicide tolerant plants. Associated with this concern was the spread of the herbicide tolerant trait to non-transgenic plants. The review also indicated that there is some question as to whether transgenic development has affected pesticide use in an environmentally positive way.

Surveyed producers indicated that herbicide use based on value of product per acre was 40% higher for conventional systems verses transgenic systems, but the number of herbicide applications was actually higher for transgenics (2.07 versus 1.78). The economic model estimated this reduction in chemical use to be 1,500 tonnes in 1997 and 6,000 tonnes in 2000. Case study results were less conclusive in regard to level of herbicide use with five transgenic producers reporting less use, four indicating more use, and the remainder no change. Conventional canola growers reported using a greater array of herbicides including pre-emergent types requiring incorporation. Herbicides, used on transgenic varieties, were perceived as less "harsh" than those used on conventional varieties.

According to the survey results, fertilizer application rates by transgenic producers, in terms of value of product per acre, were 6.5% higher than conventional producers. When adjustments were made for differences in summer fallow acres, no difference was seen in fertilizer use. This conclusion was substantiated by case study information, which indicated that the rate of fertilizer application was basically the same for both transgenic and conventional systems.

Energy consumption in terms of fuel used was found to be lower for transgenic production due to fewer field operations. Minimum till and direct seeding is a more available option with the herbicide regime used on transgenic varieties. As a result, fuel savings attributed to growing transgenics canola has grown from 9.5 million litres in 1997 to 31.2 million litres in 2000.

Social concerns expressed by case study participants centered around the lack of knowledge about transgenic production by those outside industry. Although most producers felt that there was minimal immediate effect, they were concerned about the public's acceptance of transgenic production and the future market for transgenic canola seed and oil. TUA's, along with seed/herbicide company integration, are concerns to producers. They did not appreciate the increasing control by supply companies and the limiting of options available to them, such as using their own seed, etc.

In summary, the transgenic canola systems had a positive economic and agronomic impact when compared to the conventional canola systems in western Canada for the four year period, 1997 to 2000.

Appendix 1

AGRONOMIC AND ECONOMIC ASSESSMENT OF TRANSGENIC CANOLA

Analysis of Weighted Results from the Integrated Pest Management (IPM)
Study Conducted by Koch Paul Associates, Spring 2000

Distribution of Systems by Ecozone*	Prairie n=463	Boreal n=411
Polish (non- herbicide Tolerant)	4%	11%
Argentine (non-herbicide tolerant)	34%	17%
Total Conventional (non HT)	**38%**	**28%**
SMART Trait	10%	18%
Transgenic	52%	54%
Total Herbicide Tolerant	**62%**	**72%**

*Results based on one representative field per grower. 72% of the canola acres are grown in the Prairie Ecozone, 28% in the Boreal Ecozone. *(Source: 1996 Statistics Canada Census of Agriculture).*

Question		Transgenic Sample n=459	Conventional Sample n=295
FARM PROFILE			
Average acres of canola planted in 1999		365 acres	307 acres
Average total seeded acres		1275 acres	1113 acres
Average # of fields of canola		3.27 fields	2.91 fields
Percentage seed growers		5%	7%
RESPONDENT PROFILE			
Age	<35 years	8%	7%
	35-54 years	64%	59%
	>54 years	28%	34%
Attended college/university in agriculture		24%	19%
ROTATION			
Average number between years between planting canola planted on same field		3.63 years	3.84 years
Flexibility of rotation	Fixed/Planned	43%	37%
	Variable	51%	57%
Type of rotation	Crop-fallow	2%	9%
	Crop-crop fallow	6%	17%
	Extended cropping/occasional fallow	18%	33%
	Continuous cropping/no fallow	74%	40%
Crops planted in 1998 on field	Beneficial[1]	76%	50%
	Summer fallow	16%	45%
	Non-beneficial[2]	7%	3%
	Canola	2%	3%
Percentage with adjacent fields in summer fallow in 1999		11%	25%

[1] Wheat, durum, barley, rye, oats, hay, and forages.
[2] Peas, lentils, flax, alfalfa, and sunflowers.

Appendix 1

Question		Transgenic Sample n=459	Conventional Sample n=295
CULTIVATION PRACTICES/ MECHANICAL WEED CONTROL			
Number of cultivations/ harrowing operations	zero	12%	6%
	1	9%	6%
	2	19%	17%
	3	26%	24%
	4 or more	34%	46%
Method of weed control on adjacent summer fallow fields (if applicable)	Herbicides	30%	22%
	Tillage	32%	49%
	Both	35%	25%
Percentage seeded into stubble		78%	47%
* Percentage practicing shallow tillage just before or during planting		60%	74%
SEEDING PRACTICES			
Percentage seeding…	Early	55%	40%
	Usual time for area	31%	42%
	Late	14%	17%
Row spacing	<6 inches	5%	5%
	6-<10 inches	78%	84%
	10 plus inches	12%	8%
Seed type	Foundation	4%	4%
	Certified	90%	78%
	Common	4%	16%
Treated Seed		98%	93%
Average seeding rate		5.93 lbs/acre	6.26 lbs/acre
Seeding rate relative to recommendation	Lower	10%	7%
	Recommended	77%	73%
	Higher	11%	17%
FERTILITY			
Percentage soil testing		61%	46%
Average frequency of soil testing field (if tested)		2.36 years	2.50 years
Percentage soil testing in 1999		37%	28%
Fertilizer Applications	Fall 1998	18%	11%
	Spring 1999	66%	69%
	Both	13%	10%
	Neither	3%	10%
Rate applied relative to recommendation (if applying fertilizer)	Lower	13%	22%
	Recommended	58%	52%
	Higher	25%	21%
Percentage applying manure		9%	10%
TOP WEED PROBLEMS			
* Percentage of respondents with problem…	Wild Oats	69%	63%
	Canada Thistle	50%	46%
	Wild Buckwheat	29%	40%
	Quack grass	29%	21%
	Wild Mustard	21%	24%
	Cleavers	24%	11%
	Foxtail	18%	24%
	Volunteer Cereals	18%	11%
	Sow Thistle	13%	13%

Appendix 1

Question		Transgenic Sample n=459	Conventional Sample n=295
PESTICIDE APPLICATIONS			
Percentage applying…	Herbicides	100%	85%
	Insecticides	10%	10%
	Fungicides	16%	14%
Average number of passes to apply pesticides (including cultivation application)		1.85 passes	1.59 passes
*Percentage applying as a spot or field edge treatment (if any herbicides applied)		12%	30%
Application	All self	68%	68%
	All custom	22%	21%
	Both	11%	8%
Use of shields (if spraying)	Always	33%	18%
	Sometimes	2%	4%
	Never	64%	77%
Use of buffer zones to protect sensitive areas (if adjacent to canola field)		46%	37%
DECISION PROCESS FOR WEED CONTROL			
Average % emphasis on chemical versus cultural/mechanical pest control	Chemical	77%	70%
	Cultural/Mechanical	23%	30%
Awareness of methods other than herbicides to control weeds (mean score: 1=not aware, 3=very aware)		2.05	1.90
*Percentage deciding when to apply herbicides based on… (if any applied)	Weed growth stage	54%	38%
	Crop growth stage	21%	17%
	Economic thresholds	12%	14%
	First sign of weeds	7%	6%
	Calendar dates	1%	9%
*Reasons for NOT using more non-herbicide methods of weed control	Chemicals more effective	28%	21%
	Economics	23%	17%
	Not aware of methods	18%	24%
PRACTICES TO PREVENT PEST SPREAD			
Percentage sometimes/always clean equipment after seeding		72%	79%
Percentage sometimes/always flushing tank after spraying (if sprayed)		94%	85%
Percentage sometimes/always cleaning equipment after tilling (if tilled)		29%	33%
Percentage sometimes/always clean equipment after harvesting		49%	56%
Percentage practicing sanitation methods along fence lines, roadsides, sloughs, etc		28%	27%
*Looked at weed certificate when selecting pedigreed seed and based decision on weed type and seed count		24%	12%
RECORD KEEPING, MONITORING, SCOUTING AND DIAGNOSTIC SERVICES			
*Percentage keeping written or computer records or notes on field maps re: weed problems and weed management in canola.		46%	47%
*Percentage mapping out weed problems		21%	30%
*Percentage stating that a review of the weed history/control practices played a major part in decision to seed canola on field		49%	57%
*Average number of times field scouted for weeds		3.98 times	3.95 times
*Average number of items scouted for		1.55 items	1.41 items
Percentage occasionally/frequently consulting regional forecasting services		52%	49%

Appendix 1

Question		Transgenic Sample n=459	Conventional Sample n=295
Percentage occasionally/frequently using diagnostic tools		14%	7%
Percentage occasionally/frequently monitoring weather/environment		77%	70%
Percentage occasionally/frequently using predicative models		19%	21%
Percentage occasionally/frequently monitoring resistant pest populations		49%	42%
Percentage occasionally/frequently monitoring natural enemy populations		47%	44%
Self-rated ability to identify key weeds (mean score: 1=poor, 4=excellent)		2.94	2.82
ECONOMICS			
Average $ inputs**	Seed	$24.10	$15.80
	Fertilizer	$30.20	$25.20
	Pesticides	$19.40	$19.80
	Total	$73.70	$60.80
Average Gross Return per acre		$181.90	$152.10
Difference between gross return and seed, fertilizer and pesticide input costs		$108.20	$91.30

Transgenic includes Roundup Ready, Liberty Link and Bx tolerant systems. Conventional includes non HT Argentine and Polish varieties.

* sample size for these questions was smaller (Transgenic = 254, Conventional = 149), based on those who answered the weed section of the survey.
** inclusion or exclusion of the TUA in these costs was not specified.

Notes:

The most notable differences between the conventional and transgenic sub-samples are in the areas of conservation tillage practices and economics. Transgenic growers were much more likely to be practicing reduced or no tillage, with implied benefits for soil conservation. Transgenic growers on average, reported higher seed and fertilizer costs than conventional (pesticide costs were within a similar range of the conventional producers) but also higher margins. There were significant differences in pesticide inputs between Liberty ($26.00) and Roundup ($16.80) system users. Gross returns per acre and contribution after seed, fertilizer and pesticides, were, however, within a $3 range of each other for these two systems.

Responses to all attitude statements (used to define clusters for the IPM survey) were very similar between the conventional and transgenic subsamples, with mean scores on a seven point agree/disagree scale falling within a range of under .3 of a point. Therefore, it can be concluded that transgenic versus conventional growers do not perceive that they are more or less inclined to: change their cultural practices to reduce pest impacts on canola, make it a practice to rotate herbicides because of concerns with weed resistance, know where to obtain information or attend events promoting pest management, use thresholds, use precision application of pesticides, or to be more or less concerned with personal health, the environment or the effect on beneficial organisms when selecting a pesticide. Both groups are equally as confident in their pest management decisions. Consistent with this finding is the result that conventional growers, as transgenic growers, are divided equally amongst the three cluster groups identified through the IPM survey.

Appendix 2

2000 HERBICIDE PRICING

Herbicide	Unit	Price	Recommended Rate per Acre (range)	Expected Cost (range) per acre
2,4-D Amine (500g/L)	l	$4.55	285 ml - 1.7L	$1.30 - 7.74
2,4-D Amine (600g/L)	l	$5.45	243 ml - 1.34L	$1.32 – 7.30
2,4-D Ester (600g/L)	l	$5.92	210 ml - 1.1L	$1.24 – 6.51
2,4-D Ester (700g/L)	l	$6.95	190 ml - 1.0L	$1.32 – 6.95
Accord	kg	$160.20	55 – 67 g	$8.81 – 10.73
Advance 10G	kg	$3.13	4.4 – 6.9 kg	$13.77 – 22.77
Assure II	l	$82.50	150 – 300 ml	$12.38 – 24.75
Avadex BW	kg	$2.53	4.4 – 8.9 kg	$11.13 – 22.52
Avadex Microactiv	kg	$2.68	4.4 – 8.9 kg	$11.79 – 23.85
Banvel II	l	$32.90	95 ml – 1.9 L	$3.13 – 62.51
Bonanza 10G	kg	$3.13	2.2 – 6.9 kg	$6.89 – 21.60
Bonanza 400	l	$11.00	565 – 850 ml	$6.22 – 9.35
Compas	case	$838.00	40 ac/cs	$20.95
Credit	l	$8.50	305 ml – 1.4 L	$2.59 - 11.90
Edge – granular	kg	$1.96	6.9 – 11.3 kg	$13.50 – 22.15
Edge DC	kg	$26.10	0.57 – 0.93 kg	$14.88 – 24.27
Fortress	kg	$3.04	4.5 – 6.9 kg	$13.68 – 20.98
Freedom Gold	case	$878.00	Assure @200ml Freedom @8g	$21.95
Fusion	case	$239.00	185ml Comp 1, 325ml Comp 2	$11.95
Glyfos	l	$8.95	305 ml – 1.4 L	$2.73 – 12.53
Glyphos Preharvest	l	$8.95	1 L	$8.95
Gramoxone	l	$19.15	1.1 L	$21.07
Gramoxone PDQ	l	$10.00	0.8 – 1.6 L	$8.00 – 16.00
Hoegrass 284	l	$13.43	1.0 – 1.13 L	$13.43 – 15.18
Hoegrass II	l	$13.85	1.4 L	$19.39
Liberty	l	$17.00	810 ml – 1.62 L	$13.77 – 27.54
Lontrel	l	$137.05	85 – 336 ml	$11.65 – 46.05
MCPA Amine	l	$6.25	280 ml – 1.7 L	$1.75 – 10.63
MCPA Ester	l	$7.15	280 ml – 1.1 l	$2.00 – 7.87
MCPA K-Salt	l	$5.40	375 – 850 ml	2.03 – 4.59
MCPA Sodium Salt 300	l	$4.72	485 ml – 2.85 L	2.29 – 13.43
Muster	g	$1.87	8 – 12 g	14.96 – 22.44
Muster Gold	case	$390.00	Assure@400ml Muster@8g	19.50
Muster Gold II	case	$780.00	Assure@200m Muster @8g	19.50
Odyssey	g	$1.51	12 – 17 g	18.12 – 25.67
Pardner	l	$19.43	405 – 485 ml	7.87 – 9.42
Poast Ultra	l	$88.45	130 – 445 ml	11.50 – 39.36
Puma Super	l	$39.50	202 – 404 ml	7.98 – 15.96
Pursuit	l	$254.36	85 ml	21.62
Refine Extra	g	$0.69	8 g	5.52
Renegade	l	$8.15	305 ml – 1.4 L	2.49 – 11.41
Rival 10G	kg	$3.13	4.5 – 6.9 kg	14.09 – 21.60

Appendix 2

Herbicide	Unit	Price	Recommended Rate per Acre (range)	Expected Cost (range) per acre
Rival 60DF	kg	$17.45	525 – 1135 g	9.16 – 19.81
Rival EC	l	$12.79	650 ml – 1.38 L	8.31 – 17.65
Roundup Dry	kg	$15.27	0.16 – 1.5 kg	2.44 – 22.91
Roundup Fast Forward	l	$10.99	1.2 L	13.19
Roundup Original	l	$8.99	0.3 – 2.8	2.70 – 25.17
Roundup Transorb	l	$9.79	0.3 – 2.8 L	2.94 – 27.41
Rustler	l	$5.99	1.0 – 1.3 L	5.99 – 7.79
Select	l	$233.00	50 – 152 ml	11.65 – 35.42
Touchdown 480	l	$9.20	0.35 – 1.4 L	3.22 – 12.88
Touchdown 640	l	$12.66	0.26 – 1.05 L	3.29 – 13.29
Treflan QR5	kg	$1.56	8.9 – 13.7 kg	13.88 – 21.37
Vantage	10 l jug	$88.98	0.3 – 2.8 L	2.66 – 24.91
Vantage Plus	10 l jug	$94.97	0.3 – 2.8 L	2.85 – 26.59
Venture	kg	$70.33	120 – 280 g	8.44 – 19.69
Victor	l	$8.95	305 ml – 1.4 L	2.73 – 12.53

Appendix 3

CASE STUDY FINANCIAL SUMMARY

	1997						1998					
	CON. n=6			TRANS. n=5			CON. n=9			TRANS. n=8		
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
Revenue												
Acres of Production	338	150	660	555	155	1200	267	10	800	372	88	1200
Estimated Yield (bu/ac, lb/ac)	25.23	5.00	34.39	26.00	20.00	33.00	30.71	15.00	40.00	37.61	32.00	48.00
Estimated On-Farm Market Price/bu, lb	8.40	7.70	9.00	8.44	8.00	8.81	8.34	8.00	9.00	8.23	7.45	9.00
Estimated Gross Revenue	212.00			219.35			256.17			309.66		
Expenses												
Variable Expenses												
Seed & TUA	13.44	9.20	19.30	20.00	13.75	27.12	11.17	5.00	21.15	25.89	18.00	40.38
Fertilizer	33.13	22.00	44.51	37.44	30.37	44.51	37.36	27.46	45.70	33.47	27.46	39.44
Chemical	30.27	14.50	43.80	30.62	24.70	42.15	28.10	13.50	40.00	23.11	8.00	40.00
Other Variable	47.48	7.00	65.71	58.31	57.02	59.59	32.96	14.00	53.58	36.60	14.00	58.33
Total Variable Expenses	124.32			146.37			109.59			119.07		
Total Other Expenses	15.67	5.48	42.00	14.28	5.48	30.00	26.00	18.00	52.00	15.87	5.48	20.01
Total Expenses	139.99			160.65			135.59			134.94		
Gross Margin	87.68			72.99			146.58			190.59		
Profit	72.01			58.71			120.58			174.72		

	1999						2000					
	CON. n=5			TRANS. n=12			CON. n=5			TRANS. n=12		
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
Revenue												
Acres of Production	158	80	300	538	50	1200	209	80	585	470	140	1200
Estimated Yield (bu/ac, lb/ac)	28.71	15.00	36.01	36.07	28.50	44.00	28.11	9.00	36.38	30.05	2.20	39.00
Estimated On-Farm Market Price/bu, lb	7.23	6.30	8.13	6.73	5.35	8.13	5.70	5.50	6.00	5.61	4.85	6.00
Estimated Gross Revenue	207.63			242.92			160.23			168.58		
Expenses												
Variable Expenses												
Seed & TUA	15.59	10.20	20.25	30.45	23.75	41.16	16.15	12.50	23.63	26.12	15.43	35.40
Fertilizer	36.61	29.00	45.70	35.87	29.00	45.70	35.67	29.00	45.70	32.25	23.00	45.70
Chemical	20.41	13.50	28.42	22.55	8.00	38.00	18.50	13.50	26.30	23.90	8.00	38.00
Other Variable	36.43	21.25	58.47	38.86	21.25	57.47	34.75	20.00	49.24	42.52	20.00	62.32
Total Variable Expenses	109.03			127.73			105.07			124.79		
Total Other Expenses	16.51	6.03	20.01	23.98	6.03	54.00	28.38	20.00	53.50	17.57	5.21	20.75
Total Expenses	125.54			151.71			133.45			142.35		
Gross Margin	98.59			115.18			55.16			43.80		
Profit	82.08			91.20			26.79			26.23		

Case #1	1997			1998			1999			2000[3]		
	Con.[1]	Trans.	SMART[2]	Con.	Trans.	SMART	Con.	Trans.	SMART	Con.	Trans.	SMART

Appendix 3

Revenue												
Acres of Production	224		130			234		320			717	
Estimated Yield (bu/ac, lb/ac)	28		33			38		42			33	
Est. On-Farm Market $/bu	9		9			8.28		6			5.75	
Estimated Gross Revenue	251.92		297			314.64		252			189.75	
Expenses												
Variable Expenses												
Seed & TUA	9.2		15			20		30			30	
Fertilizer	28.56		28.56			25.75		35			26	
Chemical	43.8		48			26.7		10			30	
Other Variable	65.71		65.71			51.53		41.4			62.32	
Total Variable Expenses	147.27		157.27			123.98		116.4			148.32	
Total Other Expenses	15.2		15.2			17.3		25			20.75	
Total Expenses	162.47		172.47			141.28		141.4			169.07	
Gross Margin	104.65		139.73			190.66		135.6			41.43	
Profit	89.45		124.53			173.36		110.6			20.68	

[1] 1997 was the last year this producer grew conventional; however, he had grown conventional for over 25 years prior.
[2] Choose SMART for a field that had wild radish problem.
[3] 2000 witnessed first year of air drilling and direct seeding.

Case #2	1997[1]			1998			1999			2000		
	Con.	**Trans.**	**SMART**	**Con.**	**Trans.[2]**	**SMART**	**Con.**	**Trans[3].**	**SMART**	**Con.**	**Trans.**	**SMART**
Revenue												
Acres of Production				160	160		80	240	80	80	160	80
Estimated Yield (bu/ac, lb/ac)				38.8	38.47		33.95	33.95	38.8	33.95	37.345	38.8
Est. On-Farm Market $/bu				8.25	8.25		7.75	7.75	7.75	5.5	5.5	5.5
Estimated Gross Revenue				320.1	317.38		263.11	263.11	300.7	186.73	205.4	213.4
Expenses												
Variable Expenses												
Seed & TUA				8.0325	18.69		20.25	41.16	18.9	23.625	34.541	18.9
Fertilizer				29	29		29	29	29	29	29	29
Chemical				13.5	8		13.5	8	0	13.5	8	
Other Variable				27.75	27.75		29.04	29.04	29.04	49.24	49.24	49.24
Total Variable Expenses				78.283	83.44		91.79	107.2	76.94	115.37	120.78	97.14
Total Other Expenses				20.01	20.01		20.01	20.01	20.01	20.01	20.01	20.01
Total Expenses				98.293	103.45		111.8	127.21	96.95	135.38	140.79	117.15
Gross Margin				241.82	233.94		171.32	155.91	223.76	71.36	84.616	116.26
Profit				221.81	213.93		151.31	135.9	203.75	51.35	64.606	96.25

[1] Financial records for 1997 were not available.
[2] Sclerotina problems in half of the transgenic acreage.
[3] Sclerotina problems in transgenic crops. Experienced about 16 inches of rain.

Case #3	1997[1]			1998[2]			1999[3]			2000[5]		
	Con.	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.[4]**	**SMART[5]**
Revenue												
Acres of Production				155		300	150	385	150	160	140	155
Estimated Yield (bu/ac, lb/ac)				26.6		28.8	26.6	32.393	24.84	33.12	17.1	

Appendix 3

Est. On-Farm Market $/bu				8		8	6.75	6.75	6.75	5.5	5.5	
Estimated Gross Revenue				212.8		230.4	179.55	218.65	167.67	182.16	94.05	
Expenses												
Variable Expenses												
Seed & TUA				8.7		19.5	16.25	32.6	6.5	15	31.75	21
Fertilizer				45.7		45.7	45.7	45.7	45.7	45.7	45.7	45.7
Chemical				17.5		19.3	17.5	21.6	19.3	17.5	21.6	19.3
Other Variable				35.95		35.95	36.95	36.95	36.95	37.95	37.95	37.95
Total Variable Expenses				107.85		120.45	116.4	136.85	108.45	116.15	137	123.95
Total Other Expenses				20		20	20	20	20	20	20	20
Total Expenses				127.85		140.45	136.4	156.85	128.45	136.15	157	143.95
Gross Margin				104.95		109.95	63.15	81.803	59.22	66.01	-42.95	-124
Profit												

[1] Financial records for 1997 were not available.
[2] Experienced some hail but little impact. Some Sclerotina problems in the SMART varieties.
[3] Experienced hail on transgenic crops.
[4] Hail damage on transgenic and SMART fields.
[5] All fields experienced drought stress.

Case #4	**1997**			**1998[1]**			**1999**			**2000[3]**		
	Con.	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.[2]**	**SMART**	**Con.**	**Trans.**	**SMART**
Revenue												
Acres of Production											410	160
Estimated Yield (bu/ac, lb/ac)								34.4	35		34.009	34.475
Est. On-Farm Market $/bu								7.48	7.48		6	6
Estimated Gross Revenue								257.31	261.8		204.05	206.85
Expenses												
Variable Expenses												
Seed & TUA								31.67	13.91		34.2	18.9
Fertilizer								29.6	29.6		23	23
Chemical								35.05	35.05		33	33
Other Variable								27.3	27.3		27.5	27.5
Total Variable Expenses								123.62	105.86		117.7	102.4
Total Other Expenses								28.8	28.8		19	19
Total Expenses								152.42	134.66		136.7	121.4
Gross Margin								133.69	155.94		86.35	104.45
Profit								104.89	127.14		67.35	85.45

[1] Producer could only provide records for 1999 and 2000.
[2] Sclerotina problem in transgenic varieties.
[3] In 2000, frost was experienced every month of the growing season. Re-seeding was required on minimum tillage because of frost.

Case #5	**1997[1]**			**1998[2]**			**1999[2]**			**2000[3]**		
	Con.	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**
Revenue												
Acres of Production				80	110		160	130		80	160	
Estimated Yield (bu/ac, lb/ac)				33.95	38.8		36.011	38.8		36.375	39	
Est. On-Farm Market $/bu				9	9		8.125	8.125		6	6	
Estimated Gross Revenue				305.55	349.2		292.59	315.25		218.25	234	

Appendix 3

	1997 Con.	1997 Trans.	1997 SMART	1998 Con.	1998 Trans.	1998 SMART	1999 Con.	1999 Trans.	1999 SMART	2000 Con.	2000 Trans.	2000 SMART
Expenses												
Variable Expenses												
Seed & TUA				12.925	26.125		16.242	26.971		13.475	22.99	
Fertilizer				36.9	36.9		33.71	33.71		29.19	29.19	
Chemical				22.2	21.2		22.2	21.2		16.7	26.9	
Other Variable				21.25	21.25		21.25	21.25		20	20	
Total Variable Expenses				93.275	105.48		93.402	103.13		79.365	99.08	
Total Other Expenses				20	20		20	20		20	20	
Total Expenses				113.28	125.48		113.4	123.13		99.365	119.08	
Gross Margin				212.28	243.73		199.19	212.12		138.89	134.92	
Profit				192.28	223.73		179.19	192.12		118.89	114.92	

[1] Records for 1997 were not easily available.
[2] Hail causing light damage on all fields.
[3] Hail damage to 25% of the crop. Sclerotina had a minor effect as well.

Case #6	**1997[1]**			**1998**			**1999[2]**			**2000[3]**		
	Con.	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**
Revenue												
Acres of Production	500			720				755		585		
Estimated Yield (bu/ac, lb/ac)	30			40				40		9		
Est. On-Farm Market $/bu	7.7			8.1				6.8		5.8		
Estimated Gross Revenue	231			324				272		52.2		
Expenses												
Variable Expenses												
Seed & TUA	12			14				32.5		12.5		
Fertilizer	41.6			39.8				38.9		38.8		
Chemical	32			32.5				22		26.3		
Other Variable	46.1			42				44		31.8		
Total Variable Expenses	131.7			128.3				137.4		109.4		
Total Other Expenses	42			52				54		53.5		
Total Expenses	173.7			180.3				191.4		162.9		
Gross Margin	99.3			195.7				134.6		-57.2		
Profit	57.3			143.7				80.6		-110.7		

[1] Hot dry summer resulted in some petal blast.
[2] Was perceived to have been good growing conditions in 1999.
[3] 2000 was hit with drought and frost.

Case #7	**1997[1]**			**1998[2]**			**1999[3]**			**2000**		
	Con.	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**
Revenue												
Acres of Production	152	920	460		625	875	100	700			754	290
Estimated Yield (bu/ac, lb/ac)	27	25	25.663		32.5	33.497	15	44			33.257	42
Est. On-Farm Market $/bu	8	8	8		8	8	6.3	6.3			6	6
Estimated Gross Revenue	216	200	205.3		260	267.98	94.5	277.2			199.54	252
Expenses												
Variable Expenses												
Seed & TUA	19.3	24.35	24.35		27.3	12.3	10.2	23.75			15.43	15.43

	1997 Con.	1997 Trans.	1997 SMART	1998 Con.	1998 Trans.	1998 SMART	1999 Con.	1999 Trans.	1999 SMART	2000 Con.	2000 Trans.	2000 SMART
Fertilizer	44.51	44.51	44.51		39.44	39.44	38.04	38.04			32.47	32.47
Chemical	40.21	24.7	24.7		27	27	28.42	22.89			23.35	23.35
Other Variable	61.59	59.59	59.59		58.33	58.33	58.47	57.47			59.61	59.61
Total Variable Expenses	165.61	153.15	153.15		152.07	137.07	135.13	142.15			130.86	130.86
Total Other Expenses	5.48	5.48	5.48		5.48	5.48	6.03	6.03			5.21	5.21
Total Expenses	171.09	158.63	158.63		157.55	142.55	141.16	148.18			136.07	136.07
Gross Margin	50.39	46.85	52.154		107.93	130.91	-40.63	135.05			68.684	121.14
Profit	44.91	41.37	46.674		102.45	125.43	-46.66	129.02			63.474	115.93

[1] Direct seeds with no cultivation in spring. 1997 spring was very dry.
[2] Started spring burn-off practice.
[3] Started fall burn-off practice. Spring flooding therefore late in seeding conventional variety.

Case #8	**1997[1]**			**1998[2]**			**1999[3]**			**2000[4]**		
	Con.	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**
Revenue												
Acres of Production	150			80				230			160	
Estimated Yield (bu/ac, lb/ac)	27			23.5				38			31	
Est. On-Farm Market $/bu											4.85	
Estimated Gross Revenue											150.35	
Expenses												
Variable Expenses												
Seed & TUA	10			5				26.25			15.75	
Fertilizer	37			37				37			37	
Chemical	28			29				38			29	
Total Variable Expenses	75			71				101.25			81.75	
Total Other Expenses												
Total Expenses	75			71				101.25			81.75	
Gross Margin				-71				-101.3			68.6	
Profit												

[1] Direct seeded into stubble but had poor seed placement. Reseeded with spring. Spring was wet so seeding was late.
[2] Late seeding because of failure of fall seeding.
[3] Seeded twice due to poor emergence.
[4] Seeded direct but seeded too deep.

Case #9	**1997**			**1998[2]**			**1999[3]**			**2000[4]**		
	Con.	**Trans.[1]**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**
Revenue												
Acres of Production	660	200		800	320	180	300	730	300		1100	160
Estimated Yield (bu/ac, lb/ac)	34.394	20		32.825	36	27	32	28.767	30		2.2	
Est. On-Farm Market $/bu	8.5	8.5		8.5	8.5	8.5					6	
Estimated Gross Revenue	292.35	170		279.01	306	229.5					13.2	
Expenses												
Variable Expenses												
Seed & TUA	15.6	13.75		17.5	34	20	15	34	20		34	20
Fertilizer	22			45	30	30					30	30
Chemical	14.5			39	22	22					15.85	11.85

Appendix 3

Other Variable	7			14	14	14						
Total Variable Expenses	59.1	13.75		115.5	100	86	15	34			79.85	61.85
Total Other Expenses												
Total Expenses	59.1	13.75		115.5	100	86	15	34			79.85	61.85
Gross Margin	233.25	156.25		163.51	206	143.5	-15	-34			-66.65	-61.85
Profit												

1 Producer did grow transgenic canola, but the crop was considered a wreck (20% dockage).
2 Cultivation practice changed from press and drill to direct seeding. 1998 was a wet year.
3 Growing conditions were considered good in 1997 but data was not available.
4 Drought in 2000. SMART variety was baled.

Case #10	**1997**			**1998**			**1999[2]**			**2000**		
	Con.	**Trans.**	**SMART**	**Con.[1]**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.[3]**	**Trans.**	**SMART**
Revenue												
Acres of Production			247	110	88	262		50	35		187	53
Estimated Yield (bu/ac, lb/ac)			38.13		48	37		36	27		39	68
Est. On-Farm Market $/bu			8.75		7.45	7.45		6.05	6.05		5.4	5.4
Estimated Gross Revenue			333.64		357.6	275.65		217.8	163.35		210.6	367.2
Expenses												
Variable Expenses												
Seed & TUA			17.5	21.15	24.6	15.925		25	12		15.75	21.7
Fertilizer			33	38	38	38		41.5	41.5		44	44
Chemical			42	40	40	40		29.5	29.5		38	38
Other Variable			43.4	36.2	44.7	44.7		43.5	43.5		41	41
Total Variable Expenses			135.9	135.35	147.3	138.63		139.5	126.5		138.75	144.7
Total Other Expenses			18	18	18	18		18	18		18	18
Total Expenses			153.9	153.35	173.3	164.63		165.5	152.5		164.75	170.7
Gross Margin			197.74	-135.4	210.3	137.03		78.3	36.85		71.85	222.5
Profit			179.74	-153.4	184.3	111.03		52.3	10.85		45.85	196.5

1 Fall conventional froze therefore reseeded into SMART variety.
2 1999 experienced 17 inches of rainfall in June and July. Sclerotina problems were evident.
3 Producer did plant some conventional but it froze. He did not have the tools to leave the crop in.

Case #11	**1997[1]**			**1998**			**1999[2]**			**2000**		
	Con.	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**
Revenue												
Acres of Production		300		10	100	40					250	
Estimated Yield (bu/ac, lb/ac)		33		15	32	26					38.84	
Est. On-Farm Market $/bu												
Estimated Gross Revenue												
Expenses												
Variable Expenses												
Seed & TUA		17.4		5	18	6					21.84	
Fertilizer												
Chemical		25			25							
Other Variable												
Total Variable Expenses		17.4		5	43	6					21.84	

Appendix 3

	1997 Con.	1997 Trans.	1997 SMART	1998 Con.	1998 Trans.	1998 SMART	1999 Con.	1999 Trans.	1999 SMART	2000 Con.	2000 Trans.	2000 SMART
Total Other Expenses												
Total Expenses		17.4		5	43	6					21.84	
Gross Margin		-17.4		-5	-43	-6					-21.84	
Profit		-17.4		-5	0	0					-21.84	

[1] Producer reported only those costs which change between transgenic and conventional production.
[2] No canola was grown in 1999.

Case #12	**1997**			**1998**			**1999**			**2000**		
	Con.[1]	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**[2]	**SMART**
Revenue												
Acres of Production	343	155		290	373			1174			396	
Estimated Yield (bu/ac, lb/ac)	5	26		35	37.5			28.5			25.8	
Est. On-Farm Market $/bu	8.81	8.81		8.2	8.2			5.35			5.1	
Estimated Gross Revenue	44.05	229.06		287	307.5			152.48			131.58	
Expenses												
Variable Expenses												
Seed & TUA	14.52	27.12		8.2	40.38			31.05			35.4	
Fertilizer	25.1	30.37		27.46	27.46			30.23			26.13	
Chemical	23.12	42.15		31.12	16.69			17.26			13.25	
Other Variable	57.02	57.02		53.58	53.58			48.87				
Total Variable Expenses	119.76	156.66		120.36	138.11			127.41			74.78	
Total Other Expenses												
Total Expenses	119.76	156.66		120.36	138.11			127.41			74.78	
Gross Margin	-75.71	72.4		166.64	169.39			25.065			56.8	
Profit												

[1] Wet fields, 40 inches of water.
[2] Cool weather affected yield and grade.

Case #13	**1997**[1]			**1998**			**1999**			**2000**		
	Con.	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**	**Con.**	**Trans.**	**SMART**
Revenue												
Acres of Production		1200	600		1200	600		1200	600	140	1200	600
Estimated Yield (bu/ac, lb/ac)												
Est. On-Farm Market $/bu												
Estimated Gross Revenue												
Expenses												
Variable Expenses												
Seed & TUA		17.4			18	6					21.84	
Fertilizer												
Chemical					25							
Other Variable												
Total Variable Expenses					43	6					21.84	
Total Other Expenses												
Total Expenses					43	6					21.84	

Appendix 3

Gross Margin **Profit**				

[1] Producer provided limited information.

Appendix 4

SURVEY INSTRUMENT

Hello, my name is _________ and I'm calling on behalf of the Canola Council about your canola crop. I am with Vantage Research, a professional market research firm. We're conducting a very important study on behalf of the Canola Council of Canada and the provincial canola associations regarding canola varieties and methods of controlling weeds.

We would like you to participate in this study, which should take anywhere from 15 to 20 minutes of your time, depending on your answers. Your responses will be used to help the Council and the associations in furthering knowledge about the agronomics and economics of transgenic and conventional varieties across the prairies. You may need to refer to your records, as I will be asking you which crop protection products and methods you used. I want to assure you that your responses will remain confidential and no one from the sponsoring organizations will see your answers or know who participated.

[If asked about name SOURCE] Your name was provided by a company (Aventis or Monsanto) that maintains a database of farmers. Your participation will not result in your name being added to any other list for research or sales purposes.

For the purposes of this study, I need to speak to the person in your household who is most involved in making decisions about your canola production. Could I please speak to that person?

Speaking	1	**[CONTINUE]**
Yes, I'll get him/her	2	**[CONTINUE AND REPEAT INTRO]**
Not available	3	**[Qualify by asking Q1– Q2 and ARRANGE CALLBACK]**

Do you have time to complete the interview now?

Yes	1	**[CONTINUE]**
No	2	

[IF NO] We would like to set an appointment with you at a convenient time to complete the interview. I just need to ask you a few short questions to make sure I'm talking to the right person. **[QUALIFY BY ASKING Q1 – Q-2 AND ARRANGE CALLBACK]**

SECTION 1: INTRODUCTION

1. Do you make all of your weed and pest management decisions? In other words, would you be able to tell me about the varieties you grew, fertilizers and herbicides applied?
   1. Yes
   2. No **[Thank and Terminate]**
   99. Don't know / refused **[THANK AND TERMINATE]**

2. How many acres of canola will you harvest in 2000?
   1. Specify **[IF LESS THAN 80 ACRES, THANK AND TERMINATE]**
   99. Don't know / refused **[THANK AND TERMINATE]**

[READ] For the reminder of the survey, please just answer for the field(s) and varieties you already harvested or will be able to harvest.

Appendix 4

SECTION 2: VARIETIES AND SEEDING

3. I am going to read a list of types of canola. Please tell me if you planted this type or not. **[READ - IF RESPONDENT DOESN'T KNOW TYPE ASK FOR VARIETY NAME AND REFER TO VARIETY LIST in Q-5]**

A) Polish (Conventional, Non-herbicide tolerant)
B) Conventional Argentine Hybrid (Non-herbicide tolerant)
C) Conventional Argentine Open Pollinated Variety (Non-Herbicide Tolerant)
D) Liberty Link System (Herbicide tolerant)
E) Roundup Ready System (Herbicide tolerant)
F) Bromoxynil or Bx System (Herbicide tolerant)
G) Odyssey or Pursuit Smart Trait System (Herbicide tolerant) **[THANK AND TERMINATE IF NO OTHER]**
1. Yes
2. No
99. Don't know / refused [THANK AND TERMINATE]
[IF ONLY ONE TYPE OR ONE TYPE OTHER THAN ODYSSEY OR PURSUIT SMART TRAIT, GO TO Q-5]

4. **[Insert "Other than SMART Trait" if applicable]** Which one did you grow the MOST acres of? **[DO NOT READ – ACCEPT MORE THAN ONE ANSWER IF THE SAME]**

A) Polish (Conventional Non-herbicide tolerant)
B) Conventional Argentine Hybrid (Non-herbicide tolerant)
C) Conventional Argentine Open Pollinated Variety (Non-Herbicide Tolerant)
D) Liberty Link System (Herbicide tolerant)
E) Roundup Ready System (Herbicide tolerant)
F) Bromoxynil or Bx System (Herbicide tolerant)
G) 99. Don't know/refused

[**WATCH QUOTA: 36 Polish, 25 Argentine Hybrid, 139 Argentine Open Pollinated = TOTAL 200 CONVENTIONAL. 55 Liberty, 145 Roundup – you MAY get 1 or 2 Bromoxynil – count as Roundup quota = 200 Transgenic. Conventional will be harder to fill – ask Q5 for type you are trying to fill only]**

5. Which variety of **[INSERT FROM Q 3 or 4]** canola did you plant? If you planted more than one variety of this type, please just give me the variety you planted the MOST acres of. **[DO NOT READ- PROMPT IF NECESSARY – IF A TIE – ASK RESPONDENT TO GIVE JUST ONE VARIETY THAT THEY FEEL COMFORTABLE ANSWERING THE REST OF THE SURVEY ON]**

<u>Polish Varieties (Conventional)</u>
A) Hysin 100
B) Hysin 110
C) Hysyn 111
D) Hysyn 120 CS
E) Hysin/Hysyn (don't know which number)
F) 41P04 (P=Polish)
G) 41P55 (P=Polish)
H) 41P56 (P=Polish)

Appendix 4

I) 41P (don't know which number) (P=Polish)
J) Boreal
K) Parkland
L) Sunbeam
M) Cash
N) Chinook
O) Eldorado
P) Fairview
Q) Foothills
R) Goldrush
S) Horizon
T) Klondike
U) Maverick
V) Norwester
W) Shamrock
X) Valleyview
Y) Westwin
Z) Other (specify)
AA) 21. Polish (unspecified)
BB) 99. Refused

<u>Conventional Argentine Hybrid (Non-herbicide tolerant)</u>
A) AC-H102 (AC= Agriculture Canada)
B) Hyola 401
C) Hyperstar100
D) Other (specify)
E) Conventional Argentine Hybrid (Non-herbicide tolerant) (unspecified)
F) 99. Refused

<u>Conventional Argentine Open Pollinated Variety (Non-Herbicide Tolerant)</u>
A) 1134CA (CA=Canterra Seeds)
B) 1174CA (CA=Canterra Seeds)
C) 1492CA (CA=Canterra Seeds)
D) 220
E) 44A89 (A= Argentine)
F) 45A02 (A= Argentine)
G) 46A05 (A= Argentine)
H) 46A65 (A= Argentine)
I) 500
J) 96LL112 (LL = Low Linolenic)
K) Excel
L) Agassiz
M) Alliance
N) Allons
O) Apollo
P) Ascent
Q) Battleford
R) Beacon
S) Brigade
T) Castor
U) Clavet

Appendix 4

V) CNS 601 (Low Linolenic variety from IMC Cargill)
W) CNS 603 (Low Linolenic variety from IMC Cargill)
X) CNS 604 (Low Linolenic variety from IMC Cargill)
Y) Coronet
Z) Crusher
AA) Dakini
BB) Eagle
CC) Ebony
DD) Frontier
EE) Garrison
FF) Global
GG) Goliath
HH) Herald (Libred 279)
II) Hi-Q
JJ) Hudson
KK) Hylite 201
LL) Impulse
MM) Jewel
NN) LA 161 (LA= Laurate)
OO) LG3220 (LG = Limagrain)
PP) LG3222 (LG = Limagrain)
QQ) LG3260 (LG = Limagrain)
RR) LG3310 (LG = Limagrain)
SS) LG3333 (LG = Limagrain)
TT) LG3360 (LG = Limagrain)
UU) LG3369 (LG = Limagrain)
VV) LG3430 (LG = Limagrain)
WW) LG (don't know which number) (LG = Limagrain)
XX) Libred 2416
YY) Libred 279 (Herald)
ZZ) Magnum
AAA) Mercury
BBB) Millenium O1
CCC) Neptune
DDD) Nexera 500
EEE) Dynamite
FFF) Option 501
GGG) PR4389 (PR = Proven Seeds)
HHH) PR4596 (PR = Proven Seeds)
III) PR5208 (PR = Proven Seeds)
JJJ) Q2
KKK) Quantum
LLL) Sentry
MMM) Settler
NNN) Sprint
OOO) Synbrid 220
PPP) Trailblazer
QQQ) Vanguard
RRR) Venus
SSS) Wildcat
TTT) Other (specify)

Appendix 4

UUU) Conventional Argentine Open Pollinated (Non-herbicide tolerant) (unspecified)
VVV) 99. Refused

Liberty Link System
A) 2631LL (LL=Liberty Link)
B) 3850
C) 3880
D) Exceed
E) Independence
F) Innovator
G) Invigor 2063
H) Invigor 2153
I) Invigor 2163
J) Invigor 2273
K) Invigor 2463
L) Invigor 2473
M) Invigor 2563
N) Invigor 2573
O) Invigor 2663
P) Invigor 2673
Q) Invigor (don't know which number)
R) Liberator SW (SW=Svalof Weibull)
S) Other (specify)
T) Liberty Tolerant (unspecified)
U) 99. Refused

Roundup Ready System
A) 41P50 (P=Polish)
B) 41P51 (P=Polish)
C) 45A50 (A=Argentine)
D) 45A51 (A=Argentine)
E) Hyola 454RR
F) Hysyn 101 RR
G) IMC 106 (IMC= Inter Mountain Canola)
H) IMC 107 (IMC= Inter Mountain Canola)
I) IMC 108 (IMC= Inter Mountain Canola)
J) IMC (don't know which number) (IMC= Inter Mountain Canola)
K) LG3235 (LG=Limagrain)
L) LG3295 (LG=Limagrain)
M) LG3345 (LG=Limagrain)
N) LG3455 (LG=Limagrain)
O) LG3525 (LG=Limagrain)
P) LG Dawn (LG=Limagrain)
Q) LG (don't know which number) (LG=Limagrain)
R) NS2479 (NS=Pioneer Hybrid)
S) NS2360 (NS=Pioneer Hybrid)
T) NS2634 (NS=Pioneer Hybrid)
U) NS (don't know which number) (NS=Pioneer Hybrid)
V) Quest
W) Arrow SW (SW=Svalof Weibull)
X) RideR SW (SW=Svalof Weibull)

Appendix 4

Y) Other (specify)
Z) Roundup Tolerant (unspecified)
AA) 99. Refused

Bromoxynil Tolerant (Bx) System
A) 295 Bx
B) Armor Bx
C) Cartier Bx
D) Navigator (Compass)
E) Zodiac Bx
F) Other (specify)
G) Bx Tolerant (unspecified)
H) 99. Refused

6. Did you plant [VARIETY] on more than one field in 2000?

1. Yes
2. No
99. Don't know / refused

7. **[IF YES or DK/REFUSED TO Q6]** For the remainder of the survey, I want to ask you about the acres you planted with **[VARIETY].** If you treated these fields the same in terms of seeding method, weed management, herbicide applications, fertilizer, etc, and you got the same yields, then you can either answer for the combined number of acres of these fields, or for one field only…whichever is easier for you. If you treated these fields differently, then I will just ask you about one field; that would be the largest field if they were different sizes. How many acres would we be talking about?
[IF NO TO Q 6] How many acres of **[VARIETY]** did you plant on the one field?
1. Specify # acres
99. Don't know / refused **[THANK AND TERMINATE IF DK/REFUSED]**

8. What was the seeding rate in pounds per acre for these **[INSERT # OF ACRES FROM Q7]** acres?
1. Specify (lbs/acre)
99. Don't know / refused

9. Was the seed...? **[READ 1 to 3, ALLOW MULTIPLE RESPONSES]**
1. Foundation
2. Certified or
3. Common
4. Other (Specify)
99. Don't know / refused

10. What was the cost of the seed, not including custom seeding costs **[ADD IF ANSWERING FOR TRANSGENIC " or the TUA?"].**
1. bin run or used farmer's own seed (did not pay for seed)
2. Specify ($/acre) OR
3. Specify ($/lb) OR
4. Specify ($/kg)
99. Don't know / refused

Appendix 4

SECTION 3: YIELD AND GRADE

11. What was, or do you anticipate will be, the yield per acre for these **[INSERT # OF ACRES FROM Q7] acres?**
1. Specify Yield in bu/acre____ OR
2. Yield in kg/acre____ OR
3. Yield in lbs/acre___
99. Don't know / refused

12. **[ASK IF ANSWERING FOR TRANSGENIC QUOTA ONLY]** Had you planted a conventional variety instead, what do you anticipate your average yield per acre WOULD have been on these **[INSERT # OF ACRES FROM Q7]** acres this year?
1. Specify Yield in bu/acre____ OR
2. Yield in kg/acre____ OR
3. Yield in lbs/acre___
99. Don't know / refused

13. What was the grade (or what do you anticipate it will be)?
1. #1
2. #2
3. #3A
4. #3B
5. Sample
99. Don't know / refused

14. What was the dockage?
1. Specify % ___
99. Don't know / refused

15. **[ASK IF ANSWERING FOR TRANSGENIC QUOTA ONLY]** Had you planted a conventional variety instead in 2000, what do you anticipate your grade WOULD have been for this canola this year?
1. Specify
99. Don't know / refused

16. What do you estimate your net return per acre or profit will be, after all input costs, labor, etc, on this canola?
1. Specify
99. Don't know / refused

17. **[ASK IF ANSWERING FOR TRANSGENIC QUOTA ONLY]** Had you planted a conventional variety instead, what do you anticipate your net return or profit WOULD have been on these [INSERT # OF ACRES] acres this year?
1. Specify
99. Don't know / refused

18. Were you under contract as a canola seed grower in 2000?
1. Yes
2. No **[GO TO 20]**
99. Don't know / refused **[GO TO 20]**

Appendix 4

19. How much of a premium per acre, if any, did you receive, or do you anticipate receiving for this canola seed?
    1. zero
    2. Specify $/acre
    99. Don't know / refused

20. Did you direct seed this canola in 2000?
    1. Yes
    2. No
    99. Don't know / refused

21. Did you irrigate these acres in 2000?
    1. Yes
    2. No
    99. Don't know/refused

22. Were all these acres in summer fallow in 1999?
    1. Yes all
    2. Some... Specify number of acres in summer fallow
    3. None
    99. Don't know/refused

    [IF YES OR SOME to Q 22, READ] For the purposes of this survey, then, if I ask you about your practices, I mean the weed control or cultivation practices you used on these summer fallow acres in 1999 as well as the practices you used on the canola acres we are talking about in 2000.

SECTION 4 : FERTILIZER USE

23. Were fertilizers, including micronutrients, applied on these acres in **[ADD…"the fall of" if NOT summer fallow in Q 22]** 1999 or spring/summer of 2000?
    1. Yes
    2 . No **[GO TO Q 34]**
    99. Don't know / refused **[GO TO Q 34]**

24. How many fertilizer applications, including custom applications were made **in [ADD…"the fall of" if NOT summer fallow in Q 22]** 1999 and spring/summer of 2000?
    1. specify # of applications
    99. Don't know/refused

25. i. **[First Application]** Can you tell me how many pounds per acre and how many acres were applied **[add "for your first application" if more than one application in Q24**]for each of... [**READ a-d.]**
    a. Nitrogen
    b. Phosphorous
    c. Potassium
    d. Sulphur

    1. specify lbs/acre AND
    2. # of acres applied
    99. Don't know/refused

Appendix 4

ii. **[SECOND Application if more than one application in Q24]** Can you tell me how many pounds per acre and how many acres were applied for your second application for each of... **[READ a-d.]**
a. Nitrogen
b. Phosphorous
c. Potassium
d. Sulphur

1. specify lbs/acre AND
2. # of acres applied
99. Don't know/refused

iii. **[THIRD Application if more than two applications in Q24]** Can you tell me how many pounds per acre and how many acres were applied for your third application for each of**... [READ a-d.]**
a. Nitrogen
b. Phosphorous
c. Potassium
d. Sulphur

1. specify lbs/acre AND
2. # of acres applied
99. Don't know/refused

[IF CAN'T ANSWER TO ANY, THEN ASK Q26 to Q30 AND RECODE ALL RESPONSES TO Q 25 AS 99]?

26. i. How many applications of anhydrous ammonia (NH3 or 82-0-0), if any, did you make in **[ADD…"the fall of" if NOT summer fallow in Q 22]** 1999 and spring/summer of 2000?
1. none **[GO TO Q 27]**
2. specify # of applications
99. Don't know/refused

ii. **[FIRST APPLICATION]** How many pounds per acre and how many acres were applied **[Add "for your first application" if more than one application in Q26i]?**
1. Specify lbs/acre OR
2. Specify total lbs AND
3. # of acres applied
99. Don't know/refused

ii. **[SECOND APPLICATION if more than one application in Q26i]** How many pounds per acre and how many acres were applied for your second application?
1. Specify lbs/acre OR
2. Specify total lbs AND
3. # of acres applied
99. Don't know/refused

27. How many applications of granular fertilizers, if any, did you make in **[ADD…"the fall of" if NOT summer fallow in Q 22]** 1999 and spring/summer of 2000?
1. Specify #
2. None [GO TO Q29]
99. Don't know/refused [GO TO Q29]

Appendix 4

28. i. **[FIRST APPLICATION]** What was the analysis, how many pounds per acre and how many acres were applied **[Add "for your first application" if more than one application in Q27]?**
a. 46-0-0
b. 34-0-0
c. 12-51-0
d. 0ther (Specify)

Specify lbs/acre OR
Specify total lbs AND
# of acres applied
99. Don't know/refused

ii. **[SECOND APPLICATION if more than one application in Q27]** What was the analysis, how many pounds per acre and how many acres were applied for your second application ?
a. 46-0-0
b. 34-0-0
c. 12-51-0
d. 0ther (Specify)

1. Specify lbs/acre OR
2. Specify total lbs AND
3. # of acres applied
99. Don't know/refused

29. How many applications of liquid fertilizers containing N,P,K or S if any, did you make in **[ADD…"the fall of" if NOT summer fallow in Q 22]** 1999 and spring/summer of 2000?
3. Specify #
4. None [GO TO Q31]
99. Don't know/refused [GO TO Q31]

30. i**. [FIRST APPLICATION]** What was the analysis, how many pounds or liters per acre and how many acres were applied (of each)? **[Add "for your first application" if more than one application in Q29]?**
a. Specify analysis
b. Specify analysis

1. Specify lbs/acre OR
2. Specify liters/acre AND
3. # of acres applied
99. Don't know/refused

ii. **[SECOND APPLICATION if more than one application in Q29]** What was the analysis, how many pounds or liters per acre and how many acres were applied of each for your second application?
a. Specify analysis
b. Specify analysis

1. Specify lbs/acre OR
2. Specify liters/acre AND
3. # of acres applied
99. Don't know/refused

Appendix 4

31. Did you apply any micronutrients in **[ADD…"the fall of" if NOT summer fallow in Q22**] 1999 and spring/summer 2000?
    1. Yes
    2. No [GO TO Q34]
    99. Don't know/refused [GO TO Q34]

32. What was the total cost of the micronutrients in dollars/acre and how many acres were applied?
    1. Specify $/acre OR
    2. Specify total $ AND
    3. # of acres applied
    99. Don't know/refused [GO TO Q34]

33. And did this cost include custom application costs?
    1. Yes
    2. No
    99. Don't know/refused

SECTION 5: HERBICIDE USE

34. In total, how many passes were made over these acres, including custom applications, to apply herbicides in **[ADD…"the fall of" if NOT summer fallow in Q22]** 1999 and spring/summer of 2000, but not including any applications made after harvest this fall?
    1. zero **[VERIFY THIS MEANS THEY APPLIED NO HERBICIDES AND GO TO Q 39]**
    2. zero **[VERIFY THIS MEANS THEY APPLIED HERBICIDES ONCE ONLY, WHEN SEEDED]**
    3. Specify # of passes **[NOT INCLUDING HERBICIDES APPLIED WITH SEEDING]**
    99. Don't know / refused

35. What was your total cost for herbicides in 2000 on these **[INSERT # OF ACRES from 7]** acres, including any herbicides applied in **[ADD…"the fall of" if NOT summer fallow in Q22] 1999 [ADD… "on the summer fallow acres".. if summer fallow in Q 22 a or b]?**
    1. Specify TOTAL cost
    99. Don't know / refused

36. [ASK IF ANSWERING FOR TRANSGENIC QUOTA ONLY] Would you say this was**….[READ 1-3]**
    1. about the same as what you would have spent if you had planted conventional variety
    2. lower than what you would have spent if you had planted a conventional variety… by how much? ____ $/acre
    3. higher than what you would have spent if you had planted a conventional variety… by how much? ___ $/acre
    99. Don't know / refused

37. **[IF SUMMER FALLOW IN Q 22 a or b, OTHERWISE GO TO Q 39]** Now I would like to ask you specifically about these canola acres that were in summer fallow in 1999 . How did you manage weed control on these summer fallow acres? **[Do Not Read – PROMPT IF NECESSARY]**
    1. Chemical/herbicides
    2. Tillage [GO TO Q39]
    3. Both
    4. None/not managed/no weeds [GO TO Q39]
    99. Don't know / refused [GO TO Q39]

Appendix 4

38. Can you give me the brand name and quantity of each type of herbicide, including tank mixes, that you used on these [INSERT # OF ACRES FROM Q 7 or 22b] summer fallow acres in 1999 in number of cases, gallons or liters prior to mixing with water? For example, if you applied Roundup and tank mixed it with 2,4-D, then please give me the quantities for each. Please include any spot treatments or field edge treatments.

[IF CAN'T GIVE VOLUME, ASK FOR NUMBER OF ACRES APPLIED] Then can you please tell me how many acres were applied, how many different applications were made as well as rates per acre applied for each product. [Interviewer note: acres should correspond with # of canola acres in 2000 from Q 7 or 22 b – if not, ask for explanation – grower may have applied around field edges or spot treated only]

[DO NOT READ a-kk. IF THEY ANSWER A BRAND WITH MULTIPLE FORMULATIONS - PROBE FOR RIGHT FORMULATION – e.g. Roundup … "Was that Roundup original, Roundup dry"…etc. Check master list if not on precode list]

a) 2,4-D
b) Advance 10G
c) Avadex BW
d) Banvel
e) Banvel II
f) Buctril M
g) Edge
h) Fusilade
i) Fusion
j) Glyfos
k) Gramoxone
l) Gramoxone PDQ
m) Harmony Total
n) Heritage 5G
o) Hoegrass II
p) Hoegrass 284
q) Horizon
r) Lontrel
s) MCPA
t) Pardner
u) Poast Ultra
v) Puma
w) Renegade
x) Roundup Fast Forward
y) Roundup Transorb
z) Roundup Original
aa) Roundup Dry
bb) Rustler
cc) Select
dd) Sweep
ee) Touchdown 480
ff) Touchdown 640
gg) Treflan/Trifluralin
hh) Victor
ii) Other (Specify)
jj) Other (Specify)

kk) Other (specify)
ll) 99. Don't know/refused

1. Quantity **AND**
2. Unit **OR**
3. Number of Applications **AND**
4. Acres treated (for each application) **AND**
5. Label rate (for each application) **OR**
6. Rate applied (for each application)
99. Don't know/refused

SECTION 6: MECHANICAL/CULTURAL WEED CONTROL

39. How many tillage operations, not including harrowing, if any, did you carry out on these **[INSERT # OF ACRES FROM Q7] acres in [ADD…"the fall of" if NOT summer fallow in Q22]** 1999 and 2000. Please don't include any operations after harvest this fall?
    1. zero
    2. Specify #
    99. Don't know / refused

40. How many harrowing operations, if any, did you carry out during this same time frame?
    1. zero
    2. Specify #
    99. Don't know / refused

41. Can you estimate the number of man-hours spent per acre surveying your fields, and scouting for weeds and other pests in **[ADD…"the fall of" if NOT summer fallow in Q22]** 1999 and in spring/summer of 2000?
    1. ____ hours/acre OR
    2. ____ hours for **[INSERT # OF ACRES FROM Q7]** acres
    99. Don't know/refused

42. Did you have any other costs associated with variety selection, weed or pest control on these **[INSERT # OF ACRES FROM Q7]** acres? For example, did you pay for the services of a crop consultant or agronomist? Did you pay for any diagnostic or predictive services regarding weeds? If so, what was the average per acre cost for these services? **[O IS A VALID RESPONSE]**
    1. Specify $/acre OR
    2. Specify total $ for **[Insert # of Acres FROM Q7]** acres
    99. Don't know/refused

SECTION 7: HISTORY, PRACTICE CHANGE AND BENEFITS

For the rest of the survey, I will sometimes refer to "transgenics". Transgenics are genetically modified varieties, sometimes called GMO's or biotechs. Liberty, Round-up Ready and Bx are the three transgenic canola systems with the herbicide tolerant gene. The Odyssey or Pursuit SMART trait system is not a transgenic. (It is herbicide tolerant, but in this case, the trait has been selected through traditional plant breeding methods.) For the rest of the survey, I'll also be asking about your general canola practices, not just about the specific field or acres we have been talking about so far.

Appendix 4

43. **[IF TRANSGENICS IN Q3]** Did you plant transgenics such as Roundup Ready, Liberty Link or Bx tolerant Canola prior to this year?
    1. Yes **[GO TO Q 45]**
    2. No **[GO to Q46]**
    99. Don't know / refused **[GO to Q46]**

44. **[IF CONVENTIONALS IN Q3]** Have you ever planted a transgenic variety such as Roundup Ready, Liberty Link or Bx tolerant Canola?
    1. Yes
    2. No **[GO to Q47]**
    99. Don't know / refused **[GO to Q 47]**

45. In which years? **[DO NOT READ. ACCEPT MULTIPLE RESPONSES]**
    1. 1995
    2. 1996
    3. 1997
    4. 1998
    5. 1999
    6. 2000 **[CODE 2000 AUTOMATICALLY IF TRANSGENICS IN Q 3]**
    99. Don't Know/Refused

46. **[IF TRANSGENICS IN Q3 OR YES TO Q44]** Why did you first decide to plant a transgenic variety such as Roundup Ready or Liberty Link? Any other reasons?
    1. Specify
    99. Don't know / refused

[GO TO Q 51 IF YES TO TRANSGENICS IN Q 3 OR 2000 in Q 45]

47. **[IF NO TO TRANSGENICS IN Q44]** Why have you not tried transgenic varieties?
    1. Specify **[GO TO Q 49]**
    99. Don't know / refused **[GO TO Q 49]**

48. **[IF ANY YEAR BUT 2000 in Q45]** Why have you not continued to plant transgenic varieties?
    1. Specify
    99. Don't know / refused

49. Has negative public opinion toward transgenic or genetically modified varieties been a factor in not planting them?
    1. Yes
    2. No
    99. Don't know/refused

50. Has concern with access to markets been a factor in not planting transgenics?
    1. Yes
    2. No
    99. Don't know/refused

[GO TO Q66 IF NO TO TRANSGENICS IN Q3]

Appendix 4

51. Have you increased your canola acreage since adopting transgenic varieties?
    1. Yes
    2. No **[GO to Q53]**
    99. Don't know / refused **[GO to Q53]**

52. Can you tell me how many acres of canola you likely would have planted in 2000, had you NOT switched to a transgenic variety?
    1. Specify number of acres
    99. Don't know / refused

53. Are you seeding your canola earlier in the spring or seeding in the fall, and if so, is this at least partly due to planting a transgenic variety?
    1. Yes – seeding early because of planting transgenics
    2. Yes – fall seeding because of planting transgenics
    3. Yes – seeding early but not due to planting transgenics
    4. Yes – fall seeding but not due to planting transgenics
    5. Not seeding early OR fall seeding
    99. Don't know / refused

54. Have you increased your use of conservation or no till practices, and if so, is this at least in part related to planting a transgenic variety?
    1. Yes – related to planting transgenics
    2. Yes –but unrelated to planting transgenics **[GO TO Q57]**
    3. Have not increased conservation/no till **[GO TO Q57]**
    99. Don't know / refused **[GO TO Q57]**

55. What were your total acres in conservation or no till for your farm BEFORE you adopted transgenic canola varieties?
    1. Specify # acres
    99. Don't know / refused

56. What were your total acres in conservation or no till in 2000?
    1. Specify # acres
    99. Don't know / refused

57. **[IF BOTH TRANSGENICS AND CONVENTIONALS GROWN IN Q3]** Do you bin your transgenic canola separately from your conventional? This is also called "crop segregation".
    1. Yes
    2. No
    99. Don't know / refused

58. Would you say that the adoption of transgenic canola has allowed you to be more or less flexible in your rotations, or has there been no change?
    1. no change
    2. more flexible
    3. less flexible
    99. Don't know / refused

59. Has weed control effectiveness been**... [READ 1-3]**
    1. about the same as what you'd expect with a conventional variety
    2. better than what you'd expect or
    3. worse than what you'd expect?
    99. Don't know / refused

Appendix 4

60. Has herbicide management to avoid weed resistance been **[READ 1-3]**
    1. about the same as with a conventional variety
    2. easier than with conventional varieties or
    3. more difficult?
    99. Don't know / refused

61. Has volunteer canola management been [READ 1-3]
    1. about the same as with a conventional variety
    2. easier than with conventional varieties or
    3. more difficult?
    99. Don't know / refused

62. Have you made any investment in specialized equipment that you wouldn't otherwise have, had you not adopted transgenics? Please describe. **[PROBE TYPE OF EQUIPMENT, COST, YEAR PURCHASED, NEW OR USED – PROMPT IF NECESSARY]**
    a. seeder
    b. sprayer/tanks
    c. cultivators/tollage equipment/harrow
    d. harvesting equipment
    e. other (Specify)

    1. None
    2. Cost AND
    3. Year Purchased AND
    4. New OR
    5. Used?
    99. Don't Know/Refused

63. Have you sold any equipment that you otherwise would have kept, had you not adopted transgenics? Please describe. [**PROBE TYPE OF EQUIPMENT, Price sold for, PROMPT IF NECESSARY]**
    a. seeder
    b. sprayer/tanks
    c. cultivators/tillage equipment/harrow
    d. harvesting equipment
    e. other (specify)

    1. None
    2. Price
    99. Don't Know/Refused

64. Have you increased your use of any of the following, since adopting transgenics? **[READ a-f]**
    a. equipment rental
    b. custom application of herbicides
    c. custom application of fertilizers
    d. custom seeding
    e. custom harvesting
    f. Anything else I haven't mentioned? (specify)

    1. Yes
    2. No
    99. Don't know / refused

Appendix 4

65. Are there any other benefits or changes regarding the quantity or types of herbicides used, herbicide application, your overall weed management program or changes to other cultural practices, such as fall seeding, as a result of using a transgenic variety?
    1. None
    2. Please explain.
    99. Don't know / refused

66. **[ALL]** From your perspective, are there any problems or disadvantages in using transgenic varieties over conventional? **[insert… "That we haven't already talked about"… IF TransgenicS IN Q3. DO NOT READ]** Any others?

	First Mention	Other Mentions
Ability to sell crop (market)	1	1
Lower yields	2	2
Higher cost per acre	3	3
Greater growing requirements	4	4
Can't deliver to usual place	5	5
Can't store with other varieties	6	6
Locked into using Roundup/Liberty	7	7
Less effective weed control	8	8
Resistance to Roundup/Liberty	9	9
Volunteer Canola Control	10	10
Technical use agreement (TUA) of $15/acre for Roundup	11	11
Negative public opinion	12	12
Other (Specify)________________	13	13
None	14	14
Don't know/refused	99	99

67. **[IF YES TO TRANSGENICS IN Q3]** Hypothetically, what would the impact be to you if transgenic canola varieties were no longer available?
    1. None
    2. Specify
    99. Don't know/refused

68. Just for classification purposes, what town is closest to your farming operation?
    1. Specify
    99. Don't know/refused

Thank you very much for your time and co-operation! Results of this study will be published in the Canola Digest.