March 2004

Plant Biotechnology –Did you know?

ECONOMIC IMPACT

- **GLOBAL: Since 1996, global acreage of biotechnology crops has increased 40-fold with a cumulative total of over 300 million hectares. In 2003, 7 million farmers in 18 countries grew 67.7 M hectares of GM crops. The top 10 GM countries in 2003, which each grew more than 50,000 hectares of GM crops, had a combined population of 3 billion people and a combined GDP of $13 trillion USD, almost half the global total GDP of $30 trillion USD.**

Source: *James, C. 2003. Preview: Global Status of Commercialized Transgenic Crops 2003. ISAAA Brief No. 30. (Links currently available at: http://www.isaaa.org/kc/bin/links/index.htm)*

- **GLOBAL: With full adoption of biotechnology, aggregate income for all regions, measured by gross national product (GNP), is estimated to rise by US$210 billion a year, by the end of the period (2006-2015).**

Source: *Australian Bureau of Agricultural and Resource Economics (ABARE). 2003. Agricultural Biotechnology: Potential for Use in Developing Countries. (Available at: http://abareonlineshop.com/product.asp?prodid=12594)*

- **UNITED STATES: In 2001, the eight biotech crops grown in the U. S. increased crop yields by 4 billion pounds and provided a net economic impact of $1.5 billion USD.**

Source: *Gianessi et al. 2002. Plant Biotechnology: Current and Potential Impact for Improving Pest Management in U. S. Agriculture. (Available at: http://www.ncfap.org)*

- **CANADA: The total economic impact of transgenic canola production systems has been estimated to be up to $464.0 million over the period from 1997 to 2000.**

Source: *An Agronomic and Economic Assessment of Transgenic Canola. 2001. Canola Council of Canada (Available at: http://www.canola-council.org/production/gmo5.html)*

- **SPAIN: Farmers in the Sarinena region of Spain are achieving benefits by growing Bt maize and on average have received an increased income of € 146 per hectare compared with growing conventional corn.**

Source: *Brookes. G. 2002. The Farm Level Impact of Using Bt Maize in Spain. (Available at: http://www.bioportfolio.com/news/btmaizeinspainfinalreport16september.pdf)*

- **EUROPE: It is estimated that nine selected biotech crops would increase yields by 8.5 billion kilograms per year and increase grower net income by € 1.6 billion per year.**

Source: *Gianessi et al. 2003. Plant Biotechnology: Potential Impact for Improving Pest Management in European Agriculture. (Available at: http://www.ncfap.org)*

ENVIRONMENTAL IMPACT: PESTICIDE REDUCTION

- **U. S.: In 2001, the eight biotech crops grown reduced pesticide use by 46 million pounds.**

Source: *Gianessi et al. 2002. Plant Biotechnology: Current and Potential Impact for Improving Pest Management in U. S. Agriculture. (Available at: http://www.ncfap.org)*

- **Europe: It is estimated that nine selected biotech crops would reduce pesticide use by 14.4 million kilograms per year compared with existing practices that would be replaced.**

Source: *Gianessi et al. 2003. Plant Biotechnology: Potential Impact for Improving Pest Management in European Agriculture. (Available at: http://www.ncfap.org)*

- **China: In 1999, Bt cotton growers in China reduced insecticide applications by an average of 67% and the kilograms of active ingredient used by an average of 80%.**

Source: *Huang et al., 2002. Plant biotechnology in China. Science, 295(5555): 674-676.*

- **Global: It is estimated that the use of GM soybean, oilseed rape, cotton and maize varieties modified for herbicide tolerance and insect protected GM cotton varieties reduced pesticide use by a total of 22 million kilograms of formulated product in the year 2000.**

Source: *Phipps, R. H. and Park, J. R. 2002. Environmental Benefits of Genetically Modified Crops: Global and European Perspectives on Their Ability to Reduce Pesticide Use. Journal of Animal and Feed Sciences 11: 1-18.*

Conversions: 1 kilogram = 2.2 pounds 1000 kilograms = 1 tonne

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ENVIRONMENTAL IMPACT: BIODIVERSITY

- **GM crops can increase productivity and will help to limit the greatest threats to natural genetic diversity – habitat loss, land fragmentation and footprint expansion.**

Source: *Ammann, K. 2003. Biodiversity and Agricultural Biotechnology – A Review of the Impact of Agricultural Biotechnology on Biodiversity.*
(Available at: http://www.botanischergarten.ch/Biotech-Biodiv/Report-Biodiv-Biotech12.pdf)

ENVIRONMENTAL IMPACT: REDUCED TILLAGE

- **Analyses conducted since the introduction of herbicide-tolerant (HT) crops strongly support the conclusion that HT crops are facilitating the continued expansion of conservation tillage (CT) practices. CT can lead to reductions in soil erosion, CO_2 production and H_2O loss.**

Source: *Fawcett, R. and Towery, D. 2002. Conservation Tillage and Plant Biotechnology – How New Technologies can Improve the Environment by Reducing the Need to Plow.*
(Available at: http://www.ctic.purdue.edu/CTIC/BiotechPaper.pdf)

SOCIETAL IMPACT ON THE DEVELOPING WORLD

- **There is an ethical obligation to explore the potential benefits of biotechnology responsibly to contribute to the reduction of poverty and improve food security and profitable agriculture in developing countries given that GM crops have demonstrated the potential to reduce environmental degradation, and to address specific health, ecological and agricultural problems which have proved less responsive to the standard agricultural tools.**

Source: *Nuffield Council on Bioethics. 2003. The Use of Genetically Modified Crops in Developing Countries. (Available at: http://www.nuffieldbioethics.org/filelibrary/pdf/gm_crops_paper_final.pdf)*

- **More than 85% of the 7 million farmers who grew biotechnology crops in 2003 were resource-poor farmers from the developing world.**

Source: *James, C. 2003. Preview: Global Status of Commercialized Transgenic Crops 2003. ISAAA Brief No. 30. (Links currently available at: http://www.isaaa.org/kc/bin/links/index.htm)*

SAFETY ASSESSMENT

- **> 1000 citations are referenced on this CD including a number of peer-reviewed studies, confirming that biotech food and feed products are as safe as conventional products.**

Source: AGBIOS "Essential Biosafety" (Available at: http://www.www.essentialbiosafety.info)

- **To date, worldwide there have been no verifiable untoward toxic or nutritionally deleterious effects resulting from the cultivation and consumption of products from GM crops and there have been no reports of these crops causing any significant environmental damage.**

Source: *GM Science Review, First Report. 2003 An open review of the science relevant to GM crops and food based on interests and concerns of the public http://www.gmsciencedebate.org.uk/report/default.htm*

- **The UK British Medical Association recently announced an interim position stating that "there is very little potential for GM foods to cause harmful health effects" and "many of the concerns expressed apply with equal vigour to conventionally derived foods".**

Source: http://www.bma.org.uk/ap.nsf/Content/GMFoods

- **A great number of other prominent national and international organizations, scientific bodies and governments have spoken in support of agricultural biotechnology.**

Source: *International Service for the Acquisition of Agri-biotech Applications (ISAAA) web site.*
(See position statement links currently available at: http://www.isaaa.org/kc/bin/links/index.htm)

MARKET IMPACT: CO-EXISTENCE OF BIOTECH, CONVENTIONAL AND ORGANIC FOODS

- **There have been 260 UK Farm Scale Evaluation field trials (FSEs), covering about 1,220 hectares of oilseed rape, sugar beet and forage maize, over the last three years and the evidence to date confirms that no conventional or organic crop have experienced any economic loss or decertification as a result of their proximity to FSEs. Recognising that the total UK farmland planted to the three crops of 693,000 hectares, of which 99.76% (691,350 hectares) is 'conventionally produced' and 0.24% (1,650 hectares) are organic, the likelihood of economic or commercial problems of co-existence remains very limited, even if there is a significant development of commercial GM crops.**

Source: *Brookes, G. Barfoot,. P. 2003. Co-existence of GM and Non GM Arable Crops: Case Study of the UK. PG Economics, Ltd. (Available at: http://www.bioportfolio.com/pdf/Co-existencecasestudyUKfinal.pdf)*

NCFAP
National Center for Food & Agricultural Policy

The National Center for Food and Agricultural Policy (NCFAP) is a private non-profit non-advocacy research organization. Originally established in 1984 at Resources for the Future with a grant from the Kellogg Foundation, the Center became an independent organization in 1992. NCFAP researchers conduct studies in four program areas: biotechnology, pesticides, international trade and development, and farm and food policy.

NCFAP News

- In Paris, NCFAP released six case studies that describe the potential impact of biotechnology in Europe. In addition, Leonard Gianessi will present the findings at EuropaBio's conference in Vienna on December 3. For more information, contact Sara Pace. (1-Dec-03)
- NCFAP welcomes former Congresswoman Jill Long Thompson, who has joined as CEO and Senior Fellow. More.. (4-August-03)
- Leonard Gianessi provided comments to EPA's Scientific Advisory Panel for atrazine. Click here to view. (17-July-03)
- After the success of NCFAP's "Plant Biotechnology: Current and Potential Impact for Improving Pest Management in US Agriculture, An Analysis of 40 Case Studies," the Center released preliminary estimates for the potential impact of Biotechnology in Europe. (24-June-2003)
- NCFAP's newest publication, "The Value of Herbicides in U.S. Crop Production," was released Thursday, April 24th at the National Press Club in Washington, DC. Click to View. (24-April-03)
- Sujatha Sankula has recently made a presentation on Comparative Environmental Impacts of Biotechnology-Derived and Convention Soybean (25-Feb-03)
- NCFAP releases its 2002 Annual Report for its Pesticide Use and Biotechnology Assessment Programs. Annual Report (01-Sep-02)
- CAST report reviews environmental impacts of biotechnology-derived crops. Press Release (25-June-02)

more news

An Agronomic and Economic Assessment of Transgenic Canola

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5. 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.

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