INQUIRY INTO PRIMARY PRODUCER ACCESS TO GENE TECHNOLOGY

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A. AG-SEED RESEARCH PTY LTD

Ag-Seed Research Pty Ltd is an oilseeds research and commercial development company with its head office at Horsham, Victoria.

Historical

The precursor company Ag-Seed Pty Ltd was formed in August 1984 following closure by Yates Seeds Ltd of its field crops division, and subsequent purchase of field crops programs by the new company Ag-Seed Pty Ltd. Principal activities at that time were hybrids of sunflower, grain and forage sorghum, maize and sweetcorn.

In 1987 Ag-Seed Pty Ltd was selected by the State Government of Victoria to be its commercial affiliate to Winter oilseed development programs, and subsequently in 1998, Ag-Seed moved its research headquarters to Horsham, centred at Victorian Institute for Dryland Agriculture.

In December 1990, the research component of Ag-Seed was split off into a new company Ag-Seed Research, with the French seed and plant products company Groupe Limagrain acquiring a majority shareholding. Limagrain is the largest seed company in Europe and around the fifth largest seed and plant products organisation globally. Limagrain has a strong emphasis on biotechnology, including through Biocem and Gene Shears in Australia.

Ag-Seed Research is undergoing a corporate realignment at present, which is likely to lead to a change in its relationship with Limagrain, and a significant increase in our involvement with biotechnology in oilseed crops, including in development of gene technology products.

Research Centres/Programs

(i) Toowoomba, Queensland:

Development of inbred and F1 hybrids of normal, confection and high oleic sunflowers.

Ag-Seed Research's Sunflower Research program commenced in 1973/74 and is significant internationally. Products include the Suncross, Sunsnack and Monosun range of hybrids. Inbreds and F1 hybrids commercialised in over fifteen countries, including Australia, South Africa, Argentina, India, Pakistan, France, Italy, Hungary, Yugoslavia, Spain, Tunisia, USA, with promising prospects in several other regions including China.

At present, the sunflower program does not utilise gene technology, but this may change in the near future. Gene technology would be a significant advantage to Ag-Seed Research's sunflower program to develop elite products both for Australia and for target markets overseas.

(ii) Horsham, Victoria:

Development of oilseed brassicas by Ag-Seed Research is centred at Horsham, Vic and includes the following activities. Two of the programs, development of HEAR and condiment mustards, are joint activities with Agriculture Victoria.

- Canola (*Brassica napus*) varieties and F1 hybrids – these are significant programs internationally.
- Canola varieties resistant to triazine herbicides.
- High erucic acid rapeseed (HEAR).
- High glucosinolate (condiment) types of mustard *Brassica juncea*.
- Canola and mustard varieties and F1 hybrids with enhanced prospects for use as natural biofumigants in field crops, horticulture, sugarcane production and forestry.
- Specialty types of canola with modified fatty acid profiles, including with enhanced levels of oleic acid, reduced levels of linolenic acid. These oils recently have been introduced into the Australian market under the Monola trademark, and they have enhanced oxidative stability, excellent frying performance and enhanced product attributes.
- This oilseed development is supported by an excellent analytical laboratory, with Ag-Seed Research being a world-leader in the development of Near Infra-Red technology for non-destructive, rapid analysis of oilseed samples.

At present, none of these programs utilise gene technology, although for around 18 months Ag-Seed Research did work with two gene constructs for canola – this work recently was terminated for commercial reasons. However Ag-Seed Research has a strong interest to utilise gene technology in the near future with canola and other brassicas, for both plant production traits as well as grain quality parameters.

Ag-Seed Research has the following brassica products commercialised or in the process of commercial release:

- Licence rights to canola varieties planted on over 80% canola area in Australia. Most of these varieties are under licence agreements with State Departments of Agriculture. In Year 2000, seven new canola cultivars will be released commercially from Ag-Seed Research, four of which are proprietary cultivars.

  These canola varieties include several non-GMO cultivars resistant to the triazine herbicides simazine and atrazine, which are planted on around 50% canola acreage in Australia and 90% in Western Australia.

  Seed production and distribution of these cultivars in Australia is undertaken by Dovuro Pty Ltd, under licence from Ag-Seed Research.

- Canola cultivars commercialised in a range of overseas countries, including USA, Chile, South Africa, Pakistan and Myanmar, with promising prospects in several other regions.

  In 1997, an Ag-Seed Research cultivar was the first Australian-bred canola accepted in Canada through the official Co-op Registration scheme. Six Ag-Seed Research cultivars are in Stage 2 Registration in Canada in 1999, and some 15 in Stage 1.

- Five specialty canola cultivars under the Monola trademark are being grown under contract production in Australia in 1999 by Nutrihealth Pty Ltd.

- The first four HEAR cultivars developed in Australia have been commercialised since 1997, under the Hemola label.

- The first condiment mustard cultivar developed in Australia was released provisionally in 1998, under the Muscon label.

- Two *Brassica juncea* cultivars for use for green manure/biofumigation purposes were released provisionally in 1999.

Expenditure

Ag-Seed Research's expenditure on development of oilseed cultivars and F1 hybrids was $1.8m in 1997/98 and $2m in 1998/99. This almost certainly is the largest expenditure on oilseed variety development in Australia by a single organisation.

Total R&D expenditure on oilseed crops since 1984 (Ag-Seed Pty Ltd) approximates $13m and since 1991 (Ag-Seed Research Pty Ltd) $10m. The company has received no government support over this period but instead has been a significant contributor to Department of Agriculture and several University oilseed programs, through royalties, lease agreements, and in-kind industry partner support, to around $8m since 1987.

B. USE OF GENE TECHNOLOGY

Gene technology is of major interest to Ag-Seed Research Pty Ltd, for both the sunflower and brassica programs.

As indicated Ag-Seed Research has worked with two gene constructs with canola (*B.napus*) in recent years, namely for development of:

- "laurate canola" (by addition of 12:0 – ACP thioesterase gene transposed from Bay Laurel tree) – under licence from Calgene Inc.;
- canola with resistance to glufosinate ammonium herbicide (by addition of "pat" gene from bacterium *Streptomyces* for resistance to glufosinate ammonium herbicide) under licence from AgrEvo Australia.

Both these programs are not continuing at present due to corporate decisions.

Ag-Seed Research has a strong interest to utilise gene technology in several program areas:

(i) Sunflowers

- Resistance to glyphosate herbicide, by licence from Monsanto Australia.

- Resistance to sclerotinia fungal disease.

- New sources of resistance to red rust (*Puccinia helianthi*).

(ii) Canola/Other Brassicas

- Resistance to glyphosate herbicide, ie. to Roundup® herbicide. Ag-Seed Research anticipates completing a licence agreement with Monsanto Australia to undertake this development in the near future.

- Introgression of genes with enhanced resistance to Blackleg ("BL") disease into canola (*Brassica napus*) from other Brassica species (eg. *B.juncea, B.carinata, B.nigra*).

- Introgression of genes for enhanced resistance to:
  - mites (eg. Red Legged Earth Mite, Bryobia mite) which damage young seedlings;
  - *Rhizoctonia* and *Sclerotinia* fungal diseases;
  - Rutherglen bugs and *Helicoverpa* earworm, during crop ripening;
  - pod shattering.

- Introgression of genes which confer modified product quality traits in canola, include to:
  - increase levels of specific fatty acids (eg. stearic acid) and for production of industrial fatty acids such as hydroxy and epoxy fatty acids (eg. ricinoleic acid, wax esters);
  - increase in levels of total protein, as well as of several essential amino acids, eg. lysine, methionine.

- Possible introgression of genes which enable production of target pharmaceutical peptides, vaccines and industrial enzymes, eg. increased carotenoids, production of industrial enzymes (eg. cellulase protease) involved in industrial processors, genes for pharmaceutical peptides (eg. thrombin, hirudin).

Publication

Attached is a copy of a paper entitled "Genetically-Modified Canola for Australia" by Dr Keith White, which was presented to the Genetically-Modified Food Conference, Melbourne in February 1999.

This paper sets out:

- The current scenario and reasons for the growth of the canola industry in Australia.

- The contribution of non-GMO technology improvements in terms of both crop production traits and product quality traits.

- Disadvantages of canola oil for extended processing and utilisation in Australia.

- The types of products of current vision for utilisation of gene technology for crop production traits (eg. herbicide resistance, resistance to BL disease and other fungal diseases) and for product quality traits (eg. fatty acids, protein composition, peptides).

- The benefits to the environment and crop production systems in Australia from target GMO's with modified crop production traits.

- The economic benefit to the farming community (ie. rural consumers) and to Australia as a whole by the utilisation of GMO canola with selected crop production traits (estimate $1bn per annum).
- The indirect benefits to food consumers from this enhanced production.
- The benefits to many sectors from development and utilisation of GMO canola/brassicas with modified crop quality traits, including the benefit to consumers of various products with modified quality traits.
- The scenario in relation to seed, oil and meal, derived from GMO products, as well as from ingestion of products in diets.

Many points highlighted in this paper represent the viewpoint of Ag-Seed Research on the role of gene technology for oilseed crops in Australia.

C. RESPONSE TO TERMS OF REFERENCE

In relation to gene technology with oilseed crops of interest for Australia, and of interest to Ag-Seed Research, the following points are made in response to the Terms of Reference of the Inquiry into Primary Producer Access to Gene Technology.

The Future Value and Importance of Genetically Modified Varieties

See also pp10 to 30, "Genetically-Modified Canola for Australia", K. White. For canola, other brassicas and sunflower crops, GM cultivars will include the following types:

Modified Crop Production Traits:

(i) Herbicide Tolerance (HT):

Main examples of GMO-HT Cultivars are :
- Resistance to glyphosate herbicides (eg. Roundup);
- Resistance to glufosinate ammonium herbicide (eg. Basta);
- Resistance to bromoxynil herbicides.

The planting of GMO-HT cultivars linked to these herbicides has major potential for canola production in Australia. Glyphosate is a broad spectrum herbicide widely-used already with field crops. Basta is used mainly in the horticulture industry but with prospects in field crops. Several other GM herbicide resistant types are being developed in overseas countries at present, eg. by Novartis.

GMO-HT cultivars also have promising potential for sunflowers for Australia, as well as for export of planting seed and licensing of cultivars in overseas regions.

(ii) Hybridisation Systems:

Production of F1 hybrids for canola/mustards requires reliable mechanisms which evoke male sterility in a female parental line, then subsequent restoration in the F1 hybrid. Gene technology is being utilised to prevent, then restore, pollen development, eg. SeedLink® system from PGS/AgrEvo. This already is in commercial InVigor® canola hybrids in Canada and is being developed in Australia by AgrEvo.

The development of F1 hybrids is a major technical challenge for the canola and *B.juncea* industries - successful hybrids will give a major boost to crop yields and also are a means of introducing new resistance genes etc. rapidly into cultivars. Hybrids are being developed by non-GMO methods as well, but gene technology is a valued option for this development.

(iii) Fungal Resistance

The major disease threat for canola in Australia, plus many overseas countries, is from Blackleg (BL) disease – caused by the fungus *Leptosphaeria maculans*.

In the early 1980's, the initial rapeseed crop was wiped out in Australia due to susceptibility of Canadian and European cultivars to BL disease. The BL fungus is very virulent and conditions in Australia optimal for BL disease.

Continued introduction of new sources of resistance to BL disease will be a critical element for sustained canola production in Australia, including for survival as well as expansion of future plantings – utilising both gene technology and conventional plant breeding.

Gene technology is being evaluated in canola to:

- **introduce BL resistance genes ex *B.carinata, B.juncea*;**
- **provide enhanced resistance mechanisms, eg. chitinase gene from bean (*Phaseolus* spp) to act on chitin in cell walls of fungi; as well as**
- **provide enhanced resistance to other fungal diseases, eg. *Rhizoctonia* root in young seedlings, *Sclerotinia* rot in flowering plants, eg. utilising gene from tobacco.**

(iv) Oil Quality

Canola oil consists of a range of fatty acids (F.A.'s) in the form of triglyceride molecules. Whilst canola oil is an excellent dietary oil, domestic usage (100,000MT p.a.) equates to <20% total oils and fats usage, and is confined predominantly to salad oils and margarines.

Further increases in domestic usage of canola oil, including for food-service applications (2/3 food market) such as for frying, spray oils and confections, as well as for non-food usage, are restricted by:

- inadequate oxidative stability (due to PUFA content);
- lack of benefits from hydrogenation (including due to increase in level of trans-fatty acids);
- inadequate level of oleic acid (C18:1%).

As a result, 45% of Australia's vegetable oils are imported – principally palm oil, with 50% saturated fats; whilst Australia's per capita usage of domestically-produced vegetable oils (13.0kg p.a.) is behind many countries (eg. USA 27.0kg p.a.).

The development of a range of specialty canolas and other Brassicas, both GMO and non-GMO, represents Australia's best potential to expand usage and processing of domestically-produced vegetable oils.

In particular, oil quality modifications using gene technology will be relevant to these expanded opportunities, including to:

- modify the chain length of retained F.A.'s (eg. increase endogenous levels of palmitic acid, stearic acid, erucic acid, linolenic acid…);
- modify the degree of unsaturation of retained F.A.'s (eg. increase levels of oleic acid, reduce levels of • linolenic acid);

- introduce genes controlling production of novel F.A.'s, such as lauric acid, myristic acid, ricinoleic acid and range of wax esters.

(v) Protein Quality, Composition

Gene technology is being evaluated in oilseed crops in several overseas countries, especially USA and Canada, to increase the levels of several essential amino acids in meals, including lysine, methionine and cysteine, as well as to reduce levels of antinutritional compounds such as phytates and glucosinolates.

Utilisation of gene technology for these purposes to enhance the feed quality of meal of canola and other oilseed crops in Australia for livestock rations, especially for monogastic animals, is of significant interest, but such uptake will reflect economic assessment as well.

(vi) Novel Constituents/"Pharming"

An exciting area for gene technology is the introduction of novel genes into canola and other oilseed crops, for production of compounds such as peptides, vaccines and industrial enzymes. Many pharmaceuticals and antibodies are protein-based, as are enzymes. Seeds produce and store proteins naturally, making seeds an alternative vehicle for such production.

"Pharming" is the use of gene technology to make pharmaceuticals from novel proteins in seed of crops such as canola.

The following examples of "pharming" applications are being considered in several overseas countries, but not to date in Australia:

- increased carotenoids, by addition of caratenoid synthesis gene;
- genes for viral proteins (eg. vaccines for rabies, influenza);
- industrial enzymes (eg. cellulase, lipase, protease), involved in industrial processors (eg. fermentation, paper manufacture);
- genes for pharmaceutical peptides (eg. thrombin, hirudin).

Oleosin proteins which encase oil storage bodies in canola seed have been genetically-engineered in Canada to carry peptides such as hirudin, a blood anti-coagulant protein. Hirudin then is recovered by enzymatic excision from oleosin extracted from harvested grain.

General Potential and Benefits of Gene Technology in Australia

Canola grain production in Australia has increased from 216,000MT in 1992 to 1.65mMT in 1998. Provisional estimates for plantings in 1999 and 1.65mha, at an average yield of $1.4MT/ha, production should approach 2.3mTM; with good prospects for further expansion. The value of the crop in 1999 will approach/exceed $1bn.

Some 65-70% canola harvest from 1998 crop will be exported as grain, together with some exports of oil.

This has several major impacts:

- the efficiency of canola grain production will be important to the success of grain and oil exports;
- the more we can tailor canola oil (+protein) to enhance domestic usage the better – whilst reducing Australia's reliance on imports of tropical oils for 45% oil and fat usage;

- the area planted to canola also can be planted to added-value canola and other Brassicas, which have been modified either by gene technology or conventional breeding, to produce grain with added-value traits. Selected gene technology conversions offer most potential in this regard.

Australia has the potential in fact to be a major world producer of canola, specialty canolas and other oilseed Brassicas, including to be a major export supplier of grain and oils, plus a major processor of added-value oils and derived products.

Australia is in a special position to exploit this potential:
- **out of season harvest of Winter/Spring grown field crops, c.f. EC, Canada;**
- **the strong level and focus of R&D activity in Brassica crops by public and private oganisations;**
- **the range of environments/niche production regions suitable for Winter Brassica production, together with the opportunity for crop isolation;**
- **the unsatisfactory level of imports of tropical oils and fats;**
- **the general scale plus reasonable cost-efficiency of canola production;**
- **the potential for significant improvement in crop yields and product diversity with GMO-based cultivars;**
- **the potential for establishment plus expansion of a diverse range of domestic processing industries.**

Australia's ability to take up this potential from Winter-based production crops will reflect our capacity to utilise and benefit from gene technology for canola and other oilseed Brassicas. A somewhat similar scenario applies to cotton and sunflowers from Summer production in Summer rainfall plus irrigated areas – although Brassicas have more flexibility for diverse gene manipulation at present than cotton and sunflowers.

Associated Technology Benefits

Canola cultivars for domestic production have to be developed in Australia due to the high incidence/virulence of BL disease plus for crop adaptation. As a result, local cultivars have the best BL resistance in the world, plus good adaptation to many overseas dryland cropping regions.

This has several major associated technology benefits:
- **Australia needs world-class R&D for successful Brassica development and production, including for development of gene technology products;**
- **there are excellent prospects for export/licensing of canola cultivars/gene technology developments/associated Intellectual Property, to overseas regions;**
- **this includes for financial returns to efficient, focussed R&D organisations involved with development of gene technology products with canola and other oilseed crops in Australia.**

Types of Organisations and General Approach for Development of Gene Technology Products

Many genes of interest or future interest for utilisation to develop cultivars and hybrids of canola and other field crops adapted to field production in Australia will be owned by large multinational corporations such as Novartis, Zeneca, Dupont-Pioneer Hi-bred, PGS-AgrEvo, Monsanto and Rhone Poulenc, whilst others will be proprietary to organisations such as Universities and CSIRO. In many cases, patents for a specific event or construct will be "overlapping" from several organisations.

In order to undertake in Australia R&D and subsequent commercialisation of gene technology products for canola, etc. organisations will require:

- "Freedom to Operate" = legal access to all relevant patented technologies and other Intellectual Property rights; in turn this involves either ownership of relevant patents and/or licences from patent owners for overlapping patents;
- proprietary rights or licence access to germplasm to be used in GMO transformation;
- acceptable commercial terms.

Breeding of field crops in Australia is a serious business, which requires a multidisciplinary approach, including:

- **ownership or licence rights to proprietary germplasm;**
- **significant investment in quality technical personnel and capital equipment;**
- **in-house laboratory for analysis of quality parameters;**
- **plant pathology, glasshouse and other required technical support (eg. haploid facility);**
- **access to genetic marker laboratory;**
- **technical capability and know-how;**
- **clearly defined protocols, including for GMO's and ability to implement these;**
- **ability to conduct expanded field trials and seed multiplication under strict quality protocols.**

Such an approach to breeding of new cultivars, even more so for gene technology products, is essential now – and will expand in the near future. Many organisations, public and private, which have had an ad-hoc approach to plant breeding, or relied on one breeder with a small support team for cultivar development, are of reducing relevance for development of field crop cultivars.

It is Ag-Seed Research's opinion that any significant breeding program, and certainly any program developing gene technology products, will need to spend at least $400,000 p.a. and desirably around $1m p.a. on relevant R&D. Ag-Seed Research itself currently spends $1.5m p.a. on oilseed brassica development, and we are only now commencing to develop GMO-based canola.

Assistance for Gene Technology Cultivar Development

The Terms of Reference for the inquiry include "Assistance to small producers to develop new varieties and the protection of the rights of independent breeders in relation to genetically-modified organisms". Such emphasis perhaps is understandable but is misplaced. Any cultivar program which expends less than around $400,000 p.a. will be of little relevant for serious cultivar development. By corollary, expenditure of public funds (directly by grants or indirectly by tax incentives) on programs of inadequate size and capability also will be misplaced and, in our opinion, a misuse of taxpayer funds.

However indirect support to breeding programs of significance will be of considerable long-term value. In particular, tax incentives along the lines of:

- **minimum 150% claims for R&D expenditure; and**
- **accelerated depreciation on capital items, together with export incentives;**

are of significant value.

We have emphasised indirect support from governments as being more relevant to serious (modest/larger) corporate R&D organisations. This is for several reasons:

- To prevent any confusion over I.P., which often may result from government grants, or from projects assisted by organisations such as Grains Research & Development Corporation;
- To allay public concerns about the use of government funds;
- To ensure a threshold level of activity already exists by the R&D entity/section;
- To prevent government funds being used to prop up an unsustainable level of input into cultivar development/gene technology products.

Public R&D organisations should ensure they obtain a minimum threshold level of activity for breeding target crops. This can be achieved in several ways:

- Consolidation of several modest size programs within an entity into a single program focussed on defined targets.
- Joint programs between organisations such as a State Department of Agriculture and GRDC.
- Expanded joint programs to include a serious industry partner willing to make a positive financial and in-kind contribution.
- Such a partner could well be the owner of a patent(s)/gene construct(s) which are desirable for incorporation into a target crop.

The contract between Monsanto Australia and Agriculture Victoria for AV to develop Roundup-Ready canola (resistant to glyphosate herbicide) using Monsanto's RR gene construct is an excellent example of such a positive symbiotic R&D activity with field crops.

Involvement of Patent Owners/Multinational Corporations

Several R&D organisations are involved in developing gene technology products from canola in Australia, under licence to organisations such as AgrEvo, Monsanto and Rhone Poulenc. These include CSIRO, Agriculture Victoria, Pioneer Hi-bred, Pacific Seeds and Ag-Seed Research. Several Universities (eg. University of Melbourne, Charles Sturt University) also are undertaking related research on gene technology, including molecular marker studies.

This range of public and private organisations, the interaction between relevant organisations, and the level of investment and focus in many of these programs augurs well for positive outcomes in developing high-yielding, reliable cultivars incorporating target genes and plant parameters. In turn, this augers well for developing varieties which will improve significantly the options and financial returns of growers.

Multinational Biotechnology Organisations in Australia

Several organisations which own important gene constructs of current relevant to Australia also, in recent years, have established their own breeding activities or otherwise have developed a direct involvement here in development of cultivars utilising gene technology. In particular this involves PGS/AgrEvo and Monsanto, whilst Dupont/Pioneer Hi-bred, Rhone Poulenc and Novartis have some activities.

The direct involvement of key players such as Monsanto Australia and AgrEvo in canola and other oilseed crops is:

- **a significant boost to the future of the canola industry;**
- **an indication of the significance of Australia for canola/oilseed Brassicas;**
- **a strong support to ensure compliance with all regulatory procedures (GMAC, NRA, ANZFA etc.), and with quality control protocols.**

The latter point deserves emphasis. Organisations such as Monsanto and AgrEvo have been singled out quite unjustly by some sections of the press and the anti-GMO lobby with a whole range of inferences and innuendo against "multinationals".

By contrast, it is the experience of Ag-Seed Research that both these organisations are very professional, with a strong emphasis on compliance with regulatory requirements, quality control, protocols and efficiencies. They also have a commitment to ensure that any products which are commercialised which they develop or which otherwise contain their gene constraints are at least identical in agronomic performance to existing cultivars such that, with its enhanced parameters, they will make a positive contribution to Australian agriculture. Good examples of these are the development and release of Ingard® cotton varieties which contain the Bt gene for resistance to *Helicoverpa* bollworm, and the current development of canola varieties resistant to glyphosate herbicide (Round-up Ready®) and glufosinate ammonium herbicide (Liberty-Link®).

General Industry and Consumer Benefits from GMO Oilseed Crops with Modified Crop Production Traits

For canola, the principal initial products of gene technology released for field production will be GMO Herbicide Tolerant cultivars, and in particular cultivars resistant to herbicides such as glyphosate (Round-up Ready®) and glufosinate ammonium (Liberty-Link®). Products with enhanced resistance to fungal diseases, including Blackleg, or with modified crop quality parameters (eg. high stearate canola, canola with epoxy fatty acids, enhanced protein quality or pharmaceutical peptides) are expected to follow over the next 5-15 years.

The release and use of GMO-Herbicide Tolerant cultivars such as Round-up Ready® canola will be in conjunction with full regulatory approval for herbicide usage and associate technology packages. These cultivars will have positive benefits for field crop production in Australia such as:

- Reduced usage of herbicides of concern to the environment, eg. from use of atrazine to triazine-tolerant (TT) canola cultivars = less concern over soil residues in subsequent crops, less concern for contamination of groundwater.

  TT canola cultivars currently comprise 45-50% canola plantings in Australia, including 85-90% plantings in Western Australia. The level of increase in canola plantings in Australia would not have occurred without TT cultivars; in fact for 1999 we could estimate canola plantings in Australia to be only 0.85mha without TT cultivars, c.f. current plantings (normal + TT) of 1.65mha.

- No yield penalty in Round-up Ready® or Liberty-Link® canola cultivars versus TT cultivars. TT cultivars have an inherent lower yield potential due to reduced chloroplast development/an altered photosynthesis pathway, and have only 80-85% yield potential of normal canola.

- More effective herbicide usage, with herbicide only applied after crops have been planted.
- More efficient spray management, including earlier planting after a late season break.
- Reduced dependence on mechanical cultivation for weed control.
- Increased crop yields due to optimal weed control.
- More effective crop rotations, including reduced fallow periods.
- Low risk of resistance developing in problem weeds, versus other herbicide resistance options (eg. c.f. imidazolinone group, for which non-GMO cultivars are to be released in Australia in Year 2000).

  This also is in contrast to the frequently-raised spectacle of "Superweeds". In fact, despite the considerable usage of glyphosate herbicide around the world, only two recorded instances of resistance – namely two isolated, site-specific incidences in Australia of resistant annual ryegrass. The mode of action of glyphosate suggests it will be a safe, effective herbicide for many years.
- Safe, effective, non-toxic chemicals. Glyphosate, for example, is considered around three times safer than common salt (despite an appalling inference of being a poison in a recent episode of "Blue Heelers").
- Reduced incidence of weed seeds in harvested canola grain, and in particular of seeds of brassica weeds such as wild radish, charlock, wild mustard. These brassica weed seeds have high levels of erucic acid in the oil, and of glucosinolates in the meal; in turn significant levels of these weed seeds could jeopardise "canola-quality" of harvested grain and export prospects.
- Potential financial benefits to growers from:
  - increased crop yields;
  - reduced farm inputs.
- Long-term benefits to farms from enhanced conservation practices – reduced herbicide carryover, reduced cultivation, reduced fallow, reduced soil erosion, increased use of minimum tillage practices, more effective crop rotations, enhanced benefits to subsequent cereal crops from biofumigation properties of canola and other brassicas.

In turn, the use of GMO-Herbicide Tolerant cultivars such as Round-up Ready® canola will have the following flow-on benefits:

- **Enable a continued expansion of canola plantings and grain production in Australia:**
  - **more intensive and efficient crop rotations;**
  - **improved yields of follow-up cereals and grain legumes;**
  - **further expansion of canola into shorter-season regions (eg. Mallee, Eyre Peninsula of SA, northern grainbelt of WA, northern NSW);**
  - **further expansion of canola into higher rainfall zones (eg. south-west Victoria, NSW Tablelands) including increased options for traditional sheep and cattle producers.**
- **Optimise quality of canola grain.**

- **Provide benefits from:**
  - **economies of scale;**
  - **improved competitive edge for export of grain and for domestic processing of oils and derived products.**

- In similar fashion, gene technology developments in other relevant areas, eg:
  - PGS hybridisation system (InVigor®);
  - resistance to earth mites (RLEM, Bryobia);
  - resistance to Blackleg disease;
  - resistance to *Sclerotinia* head rot;

  will have similar benefits to GMO-Herbicide Tolerant cultivars for canola production in Australia, including:
  - increased crop yields;
  - increased crop insurance factors;
  - reduced and/or more specific crop inputs;
  - increased grower returns.

Uptake of GMO-Cultivars by Farmers

Canola and other oilseed brassica growers, as well as in similar fashion cotton growers, etc. will be the key barometer for the benefits of gene technology in new cultivars. If growers do not recognise the benefits for their farm, crop rotations, crop inputs, and ultimately Gross Margins, they will not plant these varieties and hybrids.

Undoubtedly the three factors of most interest to canola growers from the use of GMO canola cultivars such as Round-up Ready® cultivars are:
- **increased efficiencies in weed control;**
- **increased crop returns/gross margins;**
- **increased conservation benefits for their farms.**

Many growers already use, for example, glyphosate herbicide for its total benefits to their farming system, use of this (and similar) herbicides with GMO-resistant cultivars is considered by many to be a real bonus, and the logical step in the chain.

Many growers of field crops have become very conscious of conservation; they have a strong commitment to leave their farm to their children in at least as good a condition as what they inherited it themselves, and preferably better. The interest in use of Round-up Ready® in many respect is akin to the interest in conservation tillage and Land Care practices.

In Canada in 1998, within four years of release, GMO-Herbicide Tolerant varieties and F1 hybrids comprise around 60% canola plantings, and this figure should increase. This is not due to corporate pressures or multinationals forcing GMO-cultivars on growers – it is growers reflecting their own choices.

In Canada also there are over 140 canola varieties available to growers – reflecting the level of R&D on canola. In 1999, some 44 new cultivars were approved for registration through the official Co-op Scheme, of which around 16 incorporated gene technology products.

In Australia, despite a cautious initiation, cotton growers have now strongly endorsed Ingard® cotton with enhanced resistance to *Helicoverpa* insects, and in particular because of its positive environmental benefits through reduced spray applications (3 to 5 versus 7 to 15 for conventional cotton crops).

Benefit to Consumers of GMO-Cultivars with Modified Crop Production Traits

"Consumers" generally are considered, at least in the press, to be consumers of food and related products.

The development of GMO-cultivars with modified crop production traits (eg. Round-up Ready® canola, Ingard® cotton) will have no direct impact on food quality, or benefit to food quality. Direct benefits to "consumers" will be more visible once second-stream gene technology products are developed with enhanced product quality traits.

Instead the main benefit to "consumers" will be to help significantly to ensure:
- **sustainable domestic production of canola (and other crops such as cotton);**
- **economies of scale;**
- **contained end-product prices;**
- **optimal quality of harvested grain, extracted oil and meal residues for animal feeds;**
- **reduced herbicide and chemical usage;**
- **enhanced quality of life.**

However farmers are also "consumers" and their interest in enhanced conservation practices on their farms and viable, long term returns also should be considered.

Such disparity in approach to "consumers" in relation to the gene technology debate versus other areas was evident recently when in January 1999, the "Energy and Environment" spokesperson for the Australian Consumers Association expressed strong disappointment at a court decision not to allow 30 large wind generators on Cape Bridgewater in south-west Victoria, one of the most pristine and beautiful coastal headlands in southern Australia.

Estimated Financial Impact of GMO-Cultivars Incorporating Modified Crop Production Traits

The financial impact of GMO-Cultivars incorporating modified crop production traits (eg. Round-up Ready®) on canola production in Australia by Year 2000 is estimated in the table below to be around $1bn. This is without consideration of added-value processing or benefits from GMO cultivars incorporating product-quality traits.

ESTIMATED IMPACT OF GMO CULTIVARS INCORPORATING GENETICALLY-MODIFIED CROP PRODUCTION TRAITS ON CANOLA PRODUCTION IN AUSTRALIA IN YEAR 2010

	Without GMO	With GMO
Canola Area	<2.2m ha	>=3.0m ha
% Area to GMO's	-	67% (2.0m ha)
Average Crop Yield	1.5 T/ha	1.8 T/ha
Canola Production	3.3m MT	5.4m MT
GMO Production	-	3.6m MT
Value Production	$1.26 bn	$2.26 bn
Added-Value from GMO's	-	$1.0 bn

Source: Ag-Seed Research Pty Ltd

Direct Benefits from Future Production of GMO Canola with Modified Product-Quality Traits

A range of canola, other oilseed Brassicas (eg. *Brassica juncea*, Indian mustard), and other oilseed crops are expected to be developed in Australia over the next 5 to 15 years, incorporating modified product-quality traits.

Selection of gene constructs to be included into cultivar development, and subsequent contract field production in Australia, will reflect various factors such as R&D capacity, financial costs, potential markets in Australia, export opportunities, added-value of products, etc. As a result, some opportunities will be taken up, others not.

This development and production in Australia however will have many benefits, for field production, product range, economic benefits, and for the environment:

- Will enable a significant diversity in canola/oilseed production in Australia;

- Will help overcome negative correlations for some product quality traits in conventional cultivars – eg. of reduced agronomic type/susceptibility to Blackleg disease from enhanced oleic/reduced linolenic canola.

- Has potential to add significant value to a diverse range of activities:
  - enhanced growers returns;
  - expanded oil extraction and processing;
  - expanded production of vegetable oil based products;
  - expanded industrial usage of vegetable oils;
  - new and expanded processing industries.

- Will help reduce:
  - domestic reliance on canola grain;
  - imports of tropical oils and fats and of processed products;
  - imports of high protein oilseed meals for animal feed, eg. soybeans.

- Expanded usage of vegetable oils has significant benefits for products, markets and the environment:
  - "purer", "cleaner" natural products;
  - less undesirable "contaminant" compounds c.f. animal fats = highly desirable for oleochemical manufacture plus enhanced suitability for ethnic groups (eg. Muslims);
  - greatly enhanced biodegradability of oils and products vs mineral oils;
  - ideal substitute for "synthetic" compounds based on mineral oils;
  - need for less refining or further processing in many products;
  - environmental benefits for farming, waterways, urban areas;
  - expanded processing = expanded employment, in "safer" industries and, quite often, in rural areas.

- Consumers will benefit from access to "cleaner", naturally-grown products, with enhanced biodegradability and user-friendliness, including from the substitution of products based on animal fats, mineral oils and chemical synthetics.

- Consumers also will have the opportunity to benefit from:
  - reduced levels of saturated fats and/or trans-fatty acids (from hydrogenation of unstable vegetable oils) in food products;
  - increased levels of special (dietary-essential) fatty acids;

- increased levels of essential proteins in grain, oil-free meal;
- enhanced stability and shelf-life of oils and products;
- reduced processing and hydrogenation;
- reduced use of synthetic food products – eg. as occurs in food spray oils, food drying oils.

▪ There is the potential to produce a range of pharmaceuticals and cosmetics from canola and other oilseed crops = enhanced production of naturally-grown drugs and cosmetic ingredients; cleaner production processes; potentially lower prices.

Overall, domestic production of canola/oilseed Brassicas modified by gene technology for product-quality traits has the potential to be an exciting new activity for Australia, with wide benefits for a diverse range of industries, plus direct and indirect benefits to growers and product consumers. This development and production also will be a key catalyst for Australia to become a leading world centre for R&D, for field production and for domestic processing of specialty oilseed types.

By Year 2000, one might predict that contract commercial production of selected GMO-specialty canola/Brassicas could approach 300,000MT grain, for a direct value of around $200m – without added-value benefits from downstream processing.

Presence of Transgenes in Oil, Meal

(i) Oil

There have been statements from various groups about the presence/contamination of vegetable oils extracted from GMO crops, such as from crops of Round-up Ready® canola. For example, in the Autumn 1999 issue of "WellBeing" (No. 75, pp72-75), in an article entitled "Genetic Engineering" using information "prepared by the Australian Gene-Ethics Network" the following statement is made:

"*Canola and Corn Oils.*
Gene research is aimed at producing oils for cooking margarines and shortening with more stearate. Corn and canola oils are being marketing around the world, including Australia, by Monsanto*, genetically-engineered with* Bt *(*Bacillus thuringensis*) to withstand up to 20 times higher concentrations of its weedacide Roundaup (glycophosphate)".*

Apart from the appalling technical inaccuracy of the statement, the inferences are not atypical of comments from sections of the anti-GM lobby and of the misinformation disseminated.

▪ In reality, vegetable oils such as canola oil are simply mixtures of triglycerides (glycerol plus fatty acids). They do not contain any plant tissue, DNA, other nucleic acid material, or protein material (eg. enzymes).

▪ Even where there is modification of the oil by gene technology, eg. "Laurate Canola" oil, only endogenous fatty acids will be present in the oil, not the actual enzyme(s) which altered the biochemical pathway for fatty acid synthesis nor the associate DNA.

▪ Crude vegetable oils immediately after expelling/extraction may contain foreign plant tissue in suspension (ie. not dissolved in the oil).

- Any such extraneous plant tissue in crude oil will be removed during refining processes, including water degumming, refining, bleaching and deodorising processes, which are standard procedures for RB(D) oils.

- **As a result, RB(D) canola oil and corn oil as utilised in bottled oils, margarines, plus derived processed foods will be free of any protein or DNA material, including any transgenes from GMO cultivars.**

(ii) *Meal*

Canola grain and canola meal (oil-free residue) remaining after oil extraction will contain proteins and nucleic acids, including any transgenes and associated products of gene technology. Oilseed grain and meals are used for animal feedstuffs.

- However proteins and nucleic acids in meal rapidly will be inactivated and degraded in the gastric/intestinal system after ingestion, in both monogastrics (pigs, poultry) and ruminants (sheep, cattle).

- **As a result, no transformed protein or DNA material, including transgenes from gene technology products, will be present in the meat tissue of recipient animals – the same goes for any direct human ingestion of grain or oilseed meals.**

Effectively transgenic canola and other oilseed crops of relevance for food products pose zero (minimal) health risks from ingestion of refined oil, extracted meal, or livestock which has eaten the meal.

Other Concerns for GMO-Based Food

Products from GMO-canola and other field crops at times also have been subject to claims over increased allergic reactions and reduced resistance to antibiotics. For example, Mr Bob Phelps, Director, Australian Gene Ethics Network, is quoted in "The Herald-Sun" May 23rd 1999 as saying "*food with artificial genes will cause people to develop new allergies and a resistance to antibiotics that could prove very dangerous to the human race*".

(i) Allergic Reactions

It is important to monitor all new foodstuffs regardless of origin for allergic reactions. This in fact is a key ingredient of ANZFA policy on new food products.

However, the scenario with the absence of transgenes or related proteins or nucleic acid material, in vegetable oils, ingested grain, or ingested meals derived from gene technology products indicates minimal concerns for allergic reactions.

GMO-cultivars of maize, soybeans and canola have been widely grown in North America for 4 to 5 years. Ag-Seed Research is not aware of any reported allergic reactions from ingestion of gene technology products released to date.

(ii) *Antibiotic Resistance*

Genes conferring resistance to selected antibiotics have been used as markers to label DNA containing target transfer genes, in various gene technology products released to date.

As exemplified in the quote attributed above to Mr Phelps, concern has been expressed that ingestion of gene technology products will lead to increased resistance to micro-organisms (especially gut microflora) to antibiotics.

Several points need to be made here:

- Leading medicinal antibiotics are not used to develop gene technology products. In fact, the antibiotics used would comprise <1% of all antibiotic use, and most likely their usage is confined only to use as markers in gene technology products.

- The risk of developing resistance in microorganisms from ingestion of food containing transgenes is extremely low. At the Genetically-Modified Food Conference in Melbourne in February 1999, Professor Nancy Millis, head of GMAC, considered the risk to be 1 in 10^{12} , or the same risk "as being hit by an asteroid in your backyard".

- The Canadian Food Inspection Agency in 1998 undertook a comprehensive evaluation of this matter and concluded that the risk of an antibiotic resistance marker gene being transferred from a food crop to another organism was "extremely remote".

- The widespread use of antibiotics in medicines and in animal production industries is much more likely to result in transfer of genes to, and resistance in, micro-organisms.

- Progress is being made to remove the marker gene from future gene technology products.

In summary, concerns over allergic reactions and antibiotic resistance from ingestion of GMO-canola/oilseed food products should be minimal, and are provided for by food safety requirements.

Overseas Markets

In 1998, Australia exported around 100,000MT canola grain to Europe, partially on the premise that EC would not take canola grain from Canada due to the production of GMO-canola cultivars in Canada. This has generated considerable publicity that Australia may benefit for export markets from being a source of GMO-free canola and other food products.

Several comments are made in relation to this issue:

- Australia's exports to EC in 1998 represented around 10% of our exports of canola grain, with principal markets being to China, Japan, Mexico and Asian sub-continent.

- Of Australia's prospective export markets for canola grain, only the EC has a declared position on imports of GMO-free products. Japan has an interest, but currently acquires around 70% of its canola imports from Canada – economic pressures/commodity prices will ensure this situation continues in the future.

- Both EC and Japan import significant quantities of soybeans from North America and Argentina – soybeans in both regions are derived from GMO-cultivars and there is minimal segregation.

- In most years, the EC's production of oilseed rape (= canola) is surplus to its domestic requirements – this will be the case again in 1999.

However the EC is a significant net processor and exporter of vegetable oils – in effect, it imports soybeans plus at times some canola for processing, and exports considerable quantities of oil. The dilemma for the EC in this practice is of harvest time, and contamination/non-segregation within their extraction plants.

- The EC will have a variable interest to import canola grain from Australia – and in many years will take none or very little. The EC also will seek increased imports of oilseed rape from expanding production in eastern Europe.

- Australia cannot determine the directions of its canola and other oilseed industries by the desires/vagaries of the EC market.

- **Overall, the EC policy on imports of oilseeds/exports of vegetable oils is quite hypocritical. This policy also is likely to change over time due to strong pressure from several countries, including France and Germany, to permit production of GMO field crops.**

- **There certainly will be opportunities for some segregated production in Australia of non-GMO oilseed crops, and in fact even for some districts to consider production of non-GMO cultivars (eg. Tasmania), to produce grain to meet consumer preferences.**

However, overall Australia will gain much greater benefit from production of GMO-canola and other oilseed crops in association with segregated production of non-GMO crops, than by an isolationist policy.

It also is an opportunity to expand Australia's processing of canola and export of canola oil – at the expense of the EC.

Other Matters

Unfortunately there has not been time to address all matters raised by the Terms of Reference of relevance to primary producers access to gene technology products. It has been considered important however to make comments both on some particular issues and on underlying matters relating to the issues.

We would welcome the opportunity to make expanded comments and discuss other matters of relevance to primary producers access to gene technology products at a future time.

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