

**CURRENT AWARENESS OF GENETICALLY
MODIFIED FOOD ISSUES**

PROJECT F99

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MODIFIED FOOD ISSUES**

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SUMMARY

This report is one of a series intended to provide the New Zealand Ministry of Health with an independent source of current information on issues related to genetically modified foods. This report covers developments in the period December 1999 to May 2000. Topics covered in detail are the detection of genetically modified foods and their legislative status overseas. A table summarising details of international approvals of genetically modified crop plants for food use has been updated. Two sections have been added, dealing with genetically modified food additives and processing aids, and issues concerned with feeding genetically modified plants to livestock.

1 INTRODUCTION

This project is intended to provide the Ministry of Health with an independent source of current information on genetically modified foods (GMFs). As defined in the project specification it is intended to include:

- scientific issues concerning safety, detection, and nutritional quality of genetically modified foods;
- legislative situation overseas.

The aim is to condense this material into a useful form so that the Ministry can respond to issues and enquiries from other government agencies, industry and the general public. The project also aims to provide information to support the development of an appropriate enforcement strategy on standards for genetically modified foods.

This is the second of two reports for the 1999/2000 year and covers events from 19 December 1999 to 31 May (when the draft report was submitted to the Ministry of Health).

Wider issues concerned with environmental or social effects of genetic modification and genetically modified organisms (GMOs), biodiversity, gene transfer, insect resistance etc., are only covered peripherally in this report. This reflects the division of responsibility for genetically modified material, between the Ministry of Health and the Australia New Zealand Food Authority (ANZFA) for GMFs on one hand, and the Environmental Risk Management Authority (ERMA) for GMOs on the other.

For consistency, some alternative terms have been standardised in this report. “Corn” and “maize” are interchangeable; in this document “corn” is used throughout. Canola is a genetic variation of rapeseed (or oilseed rape) developed by traditional plant breeding to be low in both erucic acid and glucosinolates (“double low” variety). In this document “rapeseed/canola” is used throughout.

Abbreviations used throughout this document:

EU: European Union

FDA: Food and Drug Administration (US)

USDA: United States Department of Agriculture

ACNFP: Advisory Committee on Novel Foods and Processes (UK)

ACRE: Advisory Committee on Releases to the Environment (UK)

ERMA: Environmental Risk Management Authority

ANZFA: Australia New Zealand Food Authority

An important source for this project is the AgNet email newsletter produced by staff at the University of Guelph. Information and archives of the newsletter can be found at:

<http://www.plant.uoguelph.ca/safefood/>

2 DETECTION OF GENETICALLY MODIFIED FOODS: RECENT DEVELOPMENTS

2.1 Government

2.1.1 Japan

The Japanese Ministry of Agriculture, Forestry and Fisheries will set standards for procedures used to test whether genetically modified ingredients have been used in food, using the Japanese Industrial Standards system, which is administered by the Ministry of International Trade and Industry. The standards will relate to the polymerase chain reaction (PCR), which is the most common method of analysing for GM foods (Source: Dow Jones 15 March 2000, via AgNet).

2.1.2 USDA laboratories

The United States Department of Agriculture's Grain Inspection Packers and Stockyards Administration (GIPSA) are establishing a biotechnology reference laboratory to be operational later in 2000. It will be located in Kansas City, and will focus on PCR and immunology based detection methods as diagnostic tools for testing biotechnology derived grains and oils. GIPSA will review, upon request, laboratories testing grains for the presence of biotechnology derived grains, and will accredit those laboratories that meet performance standards. They will also evaluate and verify test kits and procedures used for detecting GM derived materials, and establish sampling procedures (Sources: Nature Biotechnology 2000; 18: 476, and USDA press release at: <http://www.usda.gov/news/releases/2000/05/0147>).

2.2 Other

2.2.1 Enviroligix tests for Bt toxin in corn

The US company Enviroligix is marketing an immunoassay based strip test for the Cry1Ab Bt toxin in corn. This version of the Bt toxin is present in three of the major GM corn crops (Monsanto MON810, Novartis Bt 176 and Bt11). The company claims that 26% of the total US corn crop is GM, and 80% of the GM proportion is Bt toxin insect protected. Therefore this is a valuable tool for corn grower certification and identity preservation. Further information is available from:

<http://www.enviroligix.com/gmupdate.html>

The website also gives a link to the USDA developed guidelines for grain sampling from bulk shipments:

<http://www.usda.gov/gipsa/newsinfo/pubs/primer.htm#sampling>

2.2.2 DuPont Qualicon

This laboratory, based in Wilmington, Delaware USA, has announced the availability of tests for GM levels in soy and corn based products. Further information is available from:

<http://www.qualicon.com/gmo.htm>

2.2.3 IdentiGEN

IdentiGEN is a company formed by Trinity College in Dublin, which has laboratories in the Department of Genetics in the Smurfit Institute. They provide industry with services related to product identification, control and traceability, including testing services for the presence of GM soya and corn in a wide range of materials. The methods use PCR and standard GM reference materials. They also participate in European Union Ring Trials. Further information is available from:

<http://www.identigen.com/html>

2.2.4 Detection of GM corn

An October 1999 report issued by the American Crop Protection Association discusses methods for the detection of GMO grain in commerce. It examines testing methods for biotechnology derived products, addresses cost issues and whether an individual lot of grain can be determined as GMO free. It concludes there is no single, rapid or inexpensive test to verify whether a crop or crop sample is free of GM or GMO free. The report is available from:

<http://www.acpa.org/public/issues/biotech/detectmeth.html>

2.2.5 Reference materials

Commercial reference materials are currently available for three GM plants. These are:

- Roundup Ready soy (0, 0.1, 0.5, 1, 2, 5%)
- Bt-176 corn (0, 0.1, 0.5, 1, 2, 5%)
- Bt-11 corn (0, 1, 2%)

These materials were prepared by the Institute for Reference Materials and Measurements of the European Commission Joint Research Centre, and are available commercially via the Fluka chemical company. The samples were prepared from powdered but unprocessed soybeans or corn.

3 GMF APPROVALS

This table consolidates information on food use approvals of genetically modified crop plants from around the world. The focus is on food use approvals granted after assessment by the relevant national body (for example FDA in the US, ACNFP in the UK, or ANZFA in Australia and New Zealand). It does not cover approvals for environmental safety, cultivation or field trials. These are usually assessed by different national regulatory authorities (for example USDA in the US, ACRE in the UK, ERMA in New Zealand).

The primary sources for this information were:

USA: Food and Drug Administration website: <http://vm.cfsan.fda.gov/~lrd/biocon.html>

UK: Advisory Committee on Novel Foods and Processes (ACNFP) Annual Reports

Japan:

Agriculture, Forestry and Fisheries Research Council Secretariat:

<http://ss.s.affrc.go.jp/docs/sentan/eguide/commerc.htm>

Innovative Technology Division MAFF:

<http://ss.s.affrc.go.jp/docs/sentan/eguide/edevelopnew.htm>

Australia/New Zealand: ANZFA website:

<http://www.anzfa.gov.au>

The majority of this information has also been checked with the individual companies directly (Monsanto, AgrEvo, Novartis).

Note that this table does not include enzymes or vitamins derived from genetically modified organisms; these would be classed as food additives or processing aids and covered by ANZFA Standards A3 and A16 respectively.

Brand and variety (or line) names should not be regarded as exhaustive; many will exist for each transformation event.

Some background information is useful in interpreting the information about these crops.

Several companies in the genetically modified foods area have changed or merged in recent years. The five major agricultural biotechnology companies are:

Monsanto (the agricultural unit of Monsanto is to be merged with Pharmacia and Upjohn company, to form a new biotechnology company called Pharmacia. Monsanto will then concentrate on pharmaceuticals. The planned merger between Monsanto and Delta and Pine Land has been cancelled. (Source: Nature Biotechnology 2000; 18: 141))

Aventis Life Sciences (formed by the merger of AgrEvo and Rhone Poulenc)

Dupont (this company has now acquired the seed producer Pioneer Hi-Bred which produces seed for many GM crops)

Novartis

AstraZeneca (AstraZeneca PLC of Britain, and Novartis AG of Switzerland have announced plans to spin off and merge their agricultural businesses into a new company called Syngenta).

Acquisitions by these companies include:

Novartis: Ciba Geigy, Northrup King

AgrEvo: Plant Genetic Systems

Monsanto: Calgene, DeKalb Genetics, Agracetus, Ecogen

Pesticides:

Glyphosate by Monsanto is known by the trade name Roundup (the monoisopropylammonium salt).

Glufosinate by AgrEvo is also known as phosphinothricin. The salt glufosinate ammonium is also known as "Basta" and is produced by Hoechst AG.

Imidazolinone herbicides inhibit the acetolactate synthase enzyme, and include imazethapyr, the active ingredient in Cyanamid Canada's "Pursuit" herbicide.

Table 1: Products of biotechnology and food use approvals (Updated 26 May 2000)

Products that are the subject of applications to ANZFA are in bold

ANZFA Application Number	Plant	Company	Trait	Brand Names	Variety (Line) Names	Transformation event	Food Use
	Cantaloupe	Agritope Inc.	Modified fruit ripening				USA: FDA approved 1999
	Chicory (<i>Radicchio rosso</i>)	Bejo Zaden BV	Male sterility				EU: marketing for breeding authorised, human and animal food use under consideration
	Chicory (green hearted) ¹	Bejo Zaden BV	Male sterility			RM3-3, RM3-4, RM3-6	EU: marketing for breeding authorised, human and animal food use under consideration USA: FDA approved 1997
	Corn	Aventis	Male sterile				USA: FDA approved 2000
A375	Corn	AgrEvo	Glufosinate-ammonium herbicide tolerant	LibertyLink	Pride and Pioneer lines	T25	EU: cultivation, importation, storage and processing for food, feed and industrial uses approved April 1998 USA: FDA approved 1995 UK: ACNFP approved Feb 1997 Canada: Approved 3 April 1997 Japan: Approved May 1997 Argentina: Approved June 1998
	Corn ²	AgrEvo	Glufosinate-ammonium herbicide tolerant	LibertyLink		T14	USA: FDA approved 1995 UK: ACNFP approved Feb 1997 Canada: Approved 3 April 1997 Japan: Approved May 1997
	Corn	AgrEvo	Glufosinate-ammonium herbicide tolerant and insect resistant (<i>cry9c</i> gene from <i>Bacillus</i>)	StarLink		cbh351	EU: Application files in preparation USA: FDA Approved 1998 ⁶

ANZFA Application Number	Plant	Company	Trait	Brand Names	Variety (Line) Names	Transformation event	Food Use
			<i>thuringiensis</i> subsp. <i>tolworthi</i>)				
	Corn ⁴	BASF Canada	Sethoxydim tolerant			DK404SR, DK412SR	Canada: Approved Feb 1997
A385	Corn	Novartis (was Ciba-Geigy)	Lepidopteran insect (European corn borer) resistant (<i>cryIA(b)</i> gene from <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>)			Event 176	EU: cultivation and importation for use in animal feed and in processed foods approved Jan 1997 USA: FDA approved 1995 UK: ACNFP approved May 1996 Canada: Approved Dec 1995 Japan: Approved Sept 1996 Argentina: Approved 1998 Denmark: Approved 1997 The Netherlands: Approved 1997 Switzerland: Approved 1998
A380	Corn	Monsanto (was DeKalb)	Lepidopteran insect (European corn borer) resistant (<i>cryIA(c)</i> gene from <i>Bacillus thuringiensis</i>) and Glufosinate-ammonium herbicide tolerant			DBT418 (BJ16)	EU: Importation for human food and animal feed under consideration USA: FDA approved 1997 Canada: Approved April 1997 Japan: Approved November 1999
A381	Corn	Monsanto (was DeKalb, DeKalb Genetics)	Glufosinate-ammonium herbicide tolerant			DLL25 (B16)	USA: FDA approved 1996 UK: ACNFP under consideration and application resubmitted under Novel Food Regulation Canada: Approved Dec 1996 Japan: Approved November 1999
A362	Corn	Monsanto	Glyphosate herbicide tolerant	Roundup Ready		GA 21	EU: Storage and processing to non-viable products and use for animal feed under consideration. Not used for cultivation. USA: FDA approved 1998 Canada: Approved May 1999 Japan: Approved November 1999

ANZFA Application Number	Plant	Company	Trait	Brand Names	Variety (Line) Names	Transformation event	Food Use
	Corn	Monsanto	Glyphosate herbicide tolerant			MON 832	Canada: Approved September 1997.
	Corn	Monsanto	Glyphosate herbicide tolerant + Lepidopteran insect (European corn borer) resistant			MON 802	USA: FDA approved 1996 UK: ACNFP under consideration and application resubmitted under Novel Food Regulation Canada: Approved Sept 1997
A346	Corn	Monsanto	Lepidopteran insect (European corn borer) resistant (<i>cryIA(b)</i> gene from <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>)	Yieldgard		MON 810	EU: cultivation, importation, storage and processing for food, feed and industrial uses approved April 1998 USA: FDA approved 1996 UK: ACNFP approved Feb 1997 Canada: Approved Feb 1997 Japan: Approved May 1997
A386	Corn	Novartis (was Northrup King)	Lepidopteran insect (European corn borer) resistant (<i>cryIA(b)</i> gene from <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>)			Bt 11	EU: importation (but not cultivation), storage and processing for food, feed and industrial uses approved April 1998 USA: FDA approved 1996 UK: ACNFP approved Feb 1997 Canada: Approved Aug 1996 Japan: Approved Sept 1996 Switzerland: Approved 1998
	Corn	Monsanto (was Pioneer Hi-Bred)	Lepidopteran insect (European corn borer) resistant (<i>cryIA(b)</i> gene from <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>) (also includes glyphosate resistance gene but is only expressed at low levels)			MON 809	USA: Approvals applicable to MON810 also apply to MON809. This event has been licensed to another company. EU: Human food, animal feed and industrial uses under consideration UK: ACNFP approved Feb 1997 Canada: Approved Dec 1996
	Corn	Pioneer Hi-Bred	Glufosinate-				USA: FDA: Approved 1997

ANZFA Application Number	Plant	Company	Trait	Brand Names	Variety (Line) Names	Transformation event	Food Use
			ammonium herbicide tolerant and male sterile				
	Corn ³	Pioneer Hi-Bred	Imidazolinone herbicide tolerant			Lines (XA17) 3751 IR, 3417IR	Canada: Approved May 1994 (and June 1998)
	Corn ²	AgrEvo (was Plant Genetic Systems)	Male sterility + Glufosinate-ammonium herbicide tolerant			MS3	USA: FDA approved 1996 Canada: Approved July 1997
	Corn ⁴	Zeneca Seeds	Imidazolinone herbicide tolerant			Exp1910 IT	Canada: Approved July 1997
	Corn	Pioneer Hi-Bred	Insect resistant and herbicide tolerant		38B22	MON810 x T25	EU: Under consideration
A379	Cotton	Monsanto (was Calgene)/Rhône Poulenc	Bromoxynil herbicide tolerant	BXN cotton	10109, 10211, 10215, 10222, 10224		USA: FDA approved 1994 UK: ACNFP approved Jan 1997 Canada: Approved Aug 1996 Japan: Approved Dec 1997 (excludes 10109)
	Cotton	Monsanto (was Calgene)	Bromoxynil tolerant/insect protected (Lepidopteran resistant) (<i>cry1A(c)</i> gene from <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>)				USA: FDA approved 1998 Japan: Approved November 1999 (Bollgard with BXN cotton 31807)
	Cotton	DuPont	Sulfonylurea herbicide tolerant				USA: FDA approved 1996
A355	Cotton	Monsanto	Glyphosate herbicide tolerant	Roundup Ready		RRC line 1445	EU: Processing to non viable products for human food, animal feed and industrial uses under consideration USA: FDA approved 1995

ANZFA Application Number	Plant	Company	Trait	Brand Names	Variety (Line) Names	Transformation event	Food Use
							UK: ACNFP under consideration and application resubmitted under Novel Food Regulation Canada: Approved Dec 1996 Japan: Approved Dec 1997
A341	Cotton	Monsanto	Lepidopteran resistant (<i>cryIA(c)</i> gene from <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>)	Ingard (Bollgard) cotton	Lines 531, 757, 1076		EU: Processing to non viable products for human food, animal feed and industrial uses under consideration USA: FDA approved 1995 UK: ACNFP under consideration and application resubmitted under Novel Food Regulation Canada: Approved Nov 1996 (and April 1996) Japan: Approved May 1997 NZ/Australia: Unconfined planting approved in Australia, Food use approved 1999
A389 (withdrawn July 1999)	Cotton	Monsanto	Lepidopteran resistant (<i>cry2A(a)</i> gene from <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>)			1849	
	Cotton	Monsanto	Bromoxynil tolerant and insect resistant (CryIAc)	BXN-Bollgard	31807, 31808		Canada: Approved Dec 1998 Japan: Approved Nov 1999 (31807 only)
	Papaya	Cornell University	Papaya Ringspot Virus resistant		Lines 55-1 and 63-1		USA: FDA approved 1997
A382	Potato	Monsanto	Coleopteran insect resistant (<i>cryIIIA</i> gene from <i>Bacillus</i>	New Leaf	Russet Burbank, Atlantic,	Includes BT6 SPBT02-05, ATBT04-06,	USA: FDA approved 1996 and 1994 UK: ACNFP under consideration and application resubmitted under

ANZFA Application Number	Plant	Company	Trait	Brand Names	Variety (Line) Names	Transformation event	Food Use
			<i>thuringiensis</i> subsp. <i>tenebrionis</i>)		Superior	ATBT04-31, ATBT04-36	Novel Food Regulation Canada: Approved Sept 1995 and Nov 1996 Japan: Approved Sept 1996 (BT6, BT10, BT12, BT16, BT17, BT18, BT23) and May 1997 (SPBT02-05, SPBT02-07, ATBT04-06, ATBT04-30, ATBT04-31, ATBT04-36)
A383	Potato	Monsanto	Coleopteran (Colorado beetle) (<i>Bacillus thuringiensis</i> subsp. <i>tenebrionis</i>) and virus (potato virus Y) protected	New Leaf Y	Russet Burbank, Shepocity	RBK 101 SHE 15 SHE 02	USA: FDA some lines approved 1998 Canada: Approved May 1999
A384	Potato	Monsanto	Coleopteran (Colorado beetle) (<i>Bacillus thuringiensis</i> subsp. <i>tenebrionis</i>) and virus (potato leafroll virus) protected (glyphosate tolerant gene is present but not expressed at high enough levels to be effective - selection marker only)	New Leaf Plus	Russet Burbank	RBK 129 RBK 350 RBK 082	USA: FDA some lines approved 1998 Canada: Some lines approved May and Nov 1999
	Potato	AVEBE	Reduced amylose content	Cultivars Apriori and Apropos			EU: Application rejected due to concerns about antibiotic gene used. Application withdrawn.
	Potato	Amylogene	Starch modified			IEH 92-527-1	EU: Production of seed potatoes and processing to starch under consideration

ANZFA Application Number	Plant	Company	Trait	Brand Names	Variety (Line) Names	Transformation event	Food Use
A372	Rapeseed/ canola	AgrEvo	Glufosinate-ammonium herbicide tolerant	LibertyLink	HCN92, HCN 10, Independence, Innovator	Topas 19/2	EU: importation (but not cultivation), storage and processing for food, feed and industrial uses approved April 1998 USA: FDA approved March 1995 UK: ACNFP approved May 1995 Canada: Approved Feb 1995 Japan: Approved Sept 1996 and Dec 1997
A372	Rapeseed/ canola	AgrEvo	Glufosinate-ammonium herbicide tolerant	LibertyLink	HCN28, Phoenix, Exceed	T45	EU: Human food, animal feed and industrial uses under consideration (import and processing only) USA: FDA approved Sept 1997 Canada: Approved Feb 1997 Japan: Approved May 1997
	Rapeseed/ canola	AgrEvo	Glufosinate-ammonium herbicide tolerant	LibertyLink		Topas19/2 and T45 combined	ANZFA: Individual transformation events approved; combination therefore also approved. USA: Approved Canada: Approved Japan: Approved
	Rapeseed/ canola ²	AgrEvo	Glufosinate-ammonium herbicide tolerant/male sterile	LibertyLink		T177 (pHoe6/Ac)	EU: Human food, animal feed and industrial uses under consideration USA: FDA approved 1998 Canada: Approved Feb 1995 Japan: Approved Dec 1997
	Rapeseed/ canola	Monsanto (was Calgene)	Modified fatty acid profile (higher quantities of laurate and myristate)			Laurate canola 23-198, 23-18-17	USA: FDA approved 1995 UK: ACNFP Under consideration Canada: Approved April 1996
A363	Rapeseed/ canola	Monsanto	Glyphosate herbicide tolerant	Roundup Ready		GT73	USA: FDA approved 1995 UK: ACNFP approved Jan 1996 Canada: Approved Nov 1994 Japan: Approved Sept 1996

ANZFA Application Number	Plant	Company	Trait	Brand Names	Variety (Line) Names	Transformation event	Food Use
	Rapeseed/ canola	Monsanto Canada Inc.	Glyphosate herbicide tolerant			GT 200	Canada: Approved Sept 1997
	Rapeseed/ canola ³	Pioneer Hi-Bred	High oleic/low linoleic				Canada: Approved Aug 1996
	Rapeseed/ canola ³	Pioneer Hi-Bred	Imidazolinone herbicide tolerant			Lines NS738, NS1471 and NS1473	Canada: Approved April 1995
A372	Rapeseed/ canola	AgrEvo (was Plant Genetic Systems)	Male sterility and fertility restorer system for hybrid seed production + Glufosinate-ammonium herbicide tolerant	SeedLink or InVigor	PGS1, PHY14, PHY35	MS1, RF1	EU: cultivation and seed production but not food or feed use approved Feb 1996 UK: ACNFP approved Feb 1995 (B-94-2) USA: FDA approved April 1996 Canada: Approved Sept 1994 Japan: Approved Sept 1996/May 1997
A372	Rapeseed/ canola	AgrEvo (was Plant Genetic Systems)	Male sterility and fertility restorer system for hybrid seed production + Glufosinate-ammonium herbicide tolerant	SeedLink or InVigor	PGS2 (hybrid) (=PGS3880), PHY36 (hybrid), 2163, 2273 PHY23	MS1, RF2	EU: cultivation and importation for oil production approved June 1997 UK: ACNFP approved Sept 1995 (B94-2 second line) USA: FDA approved April 1996 Canada: Approved Aug 1995 Japan: Approved May 1997 and Nov 1999
A372	Rapeseed/ canola	AgrEvo (was Plant Genetic Systems)	Male sterility and fertility restorer system for hybrid seed production + Glufosinate-ammonium herbicide tolerant	Seedlink or InVigor	2363, 2463, 2473, 2373	MS8,RF3	EU: Human food, animal feed and industrial use under consideration. USA: FDA approved Sept 1998 Canada: Approved March 1997 Japan: Approved Dec 1998
A388	Rapeseed/ canola	Rhone Poulenc	Bromoxynil tolerant			Westar Oxy-235, and Oxy235	USA: FDA approved 1999 Canada: Approved July 1997 Japan: Approved November 1999
	Rapeseed/ canola	BASF AG	Phytase gene from <i>Aspergillus niger</i>	Phytaseed canola			USA: FDA approved 1999

ANZFA Application Number	Plant	Company	Trait	Brand Names	Variety (Line) Names	Transformation event	Food Use
	Soybean	AgrEvo	Glufosinate-ammonium herbicide tolerant	LibertyLink		A2704-12, A5547-127	USA: FDA approved 1998 Canada: Under review
A387	Soybean	Dupont	High oleic acid				USA: FDA approved 1997
A338	Soybean	Monsanto	Glyphosate herbicide tolerant	Roundup Ready		GTS 40-3-2	EU: importation (but not cultivation), storage and processing for food, feed and industrial uses approved May 1996 USA: FDA approved 1994. UK: ACNFP approved Feb 1995 Canada: Approved April 1996 Japan: Approved Sept 1996 NZ/Australia: Approved 1999 Also approved in Mexico, Argentina, Switzerland
ANZFA has been notified about these crops but they are not the subject of a formal application	Soybean	Novartis	Glyphosate herbicide tolerant			GTS 40-3-2 Monsanto	These plants were derived by conventional backcrossing the Monsanto Roundup Ready GTS 40-3-2 soy with Novartis soybean varieties. Approvals relevant to GTS 40-3-2 will also apply to these.
	Squash	Seminis Vegetable Seeds	CMV, WMV2 and ZYMV resistant virus resistant	Asgrow		ZW20 and CZW3 lines	USA: FDA approved 1994 and 1997 Canada: Approved April 1998
	Sugar beet	AgrEvo/KWS (product being developed by KWS in Germany, AgrEvo shares regulatory	Glufosinate-ammonium herbicide tolerant	LibertyLink		T120-7	USA: FDA: approved 1998 Japan: Approved November 1999

ANZFA Application Number	Plant	Company	Trait	Brand Names	Variety (Line) Names	Transformation event	Food Use
		responsibilities)					
A378	Sugar beet	Monsanto/Novartis	Glyphosate tolerant			GTSB77	USA: FDA approved 1998
	Tomato	AgriTope	Fruit ripening altered				USA: FDA approved 1996
	Tomato	Monsanto (was Calgene)	Fruit ripening altered (Flavr Savr)	Flavr Savr			USA: FDA approved 1994 UK: ACNFP approved Feb 1996 Canada: Approved Feb 1995 Japan: Approved Dec 1997
	Tomato	Monsanto (was Calgene)	Insect protected (<i>cryIA(c)</i> gene from <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>)				USA: FDA approved 1998
	Tomato	DNA Plant Technology Corporation	Fruit ripening altered			1345-4	USA: FDA approved 1994 Canada: Approved Nov 1995
	Tomato	Monsanto	Fruit ripening altered				USA: FDA approved 1994
	Tomato ⁵	Zeneca	Fruit ripening altered/delayed softening			TGT7-F	EU: Human food use under consideration USA: FDA approved 1994 UK: processed form (peeled and comminuted) ACNFP approved Jan 1998; processed form (tomato paste) ACNFP approved Feb 1995 and Feb 1996 (3 additional lines) Canada: Approved June 1996
	Wheat ⁴	Cyanimid	Imidazolinone tolerant			SWP965001	Canada: Approved Nov 1999

1. Has been approved by the FDA but not yet marketed in the US (Source: New Scientist 30 October 1999)
2. These products have been discontinued commercially.

3. Not a genetically modified product. Produced by mutagenesis and traditional plant breeding. Canada requires such products with novel traits to be assessed so they appear on their approvals list. Approved in other countries including EU.
4. Approved in Canada only; probably produced by mutagenesis and traditional plant breeding. Such products require specific approval only in Canada.
5. Approved by UK ACNFP as UK Competent Authority in May 1999 and by EU Scientific Committee on Food in October 1999 http://www.europa.eu.int/comm/dg24/health/sc/scf/index_en.html. Awaiting decision by European Commission.
6. Approved by FDA for use only as animal feed or as processed products where there is no dietary exposure to Cry9C protein. See note in Section 6.

4 FOOD ADDITIVES, PROCESSING AIDS AND FLAVOURINGS

This new section is intended to cover information related to GMO derived materials which are used as food additives, processing aids or flavourings. Regulation 50/2000 from the European Commission requires the labelling of foodstuffs and food ingredients containing additives and flavourings that have been genetically modified or have been produced from genetically modified organisms. The revised Guidance Notes produced to support this new regulation exempt specified additives, flavouring, carriers and solvents which are produced from GMO or GM sources, but which no longer contain novel DNA or protein resulting from genetic modification. This is likely to be the case for most food additives, flavourings or colourings. A “negative list” specifies materials derived from GM sources but which are considered to no longer contain novel DNA or protein. A list of such additives, processing aids, and flavourings, will be prepared by the EU, in the same manner as the “negative list” currently being prepared for food ingredients derived from GM plants.

The following material brings together information found during the relatively short period from when the expanded of the scope of the project was agreed.

4.1 Food enzymes derived from genetically modified micro-organisms (Roller and Goodenough, 1998)

Approximately 20 enzyme types are sold in large enough quantities for industrial scale processing. The food industry is the second largest user of enzymes; the detergent industry is the largest. The US industrial market for the use of enzymes as food processing aids is approximately US \$200 million. The world-wide market for food and industrial enzymes has been estimated as approximately US \$1 billion.

The large majority of bulk enzymes used for food processing today are manufactured using bacterial or fungal fermentation. Microbial sources of food enzymes must be non-pathogenic and non-toxicogenic. Over the years, several species of fungi (e.g. *Aspergillus niger* and *Aspergillus oryzae*) and bacteria (e.g. *Bacillus subtilis* and *Bacillus licheniformis*) have acquired a record for safe use as sources of food enzymes.

4.1.1 Chymosin

The DNA encoding calf chymosin has been successfully cloned into yeast (*Kluyveromyces lactis*), bacteria (*Escherichia coli*) and moulds (*Aspergillus niger* var. *awamori*) to give commercial products widely used in cheese manufacture. It has been estimated that over 70% of cheese production in the USA uses these sources of enzymes.

Purified chymosin from GM micro-organisms has been shown to be structurally identical to the animal derived enzyme by several methods. GM derived chymosin preparations have also been shown to be purer than animal derived products. As chymosin was the first recombinant GMO product to be approved for food use, a full safety assessment was undertaken by the US FDA, involving toxicological animal feeding trials, allergenicity tests etc. Concerns about the presence of an ampicillin resistance marker lead to the introduction of an acidification step in the purification protocol, ensuring that no functional copies of the gene were present in the final product. It has been demonstrated that there is no detectable transformable DNA in the

chymosin preparation from Pfizer, and no DNA fragments larger than 200 bases. This product now has “generally recognised as safe” (GRAS) status in the US (<http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=21&PART=184&SECTION=1685&TYPE=TEXT>)

Safety assessments were also carried out by the UK ACNFP (Annual Reports 1989, 1990 and 1992). All three recombinant chymosins are permitted for use in the USA and many European countries.

4.1.2 Recombinant enzymes for high fructose corn syrup production

The starch conversion industry is the second largest user of enzymes, after the detergent industry. By far the biggest product is high fructose corn syrup (HFCS) produced using alpha amylase, amyloglucosidase and glucose isomerase. These three enzymes perform the processes of liquefaction, saccharification and isomerisation respectively. HFCS accounts for approximately a third of the caloric sweetener market in the USA. Versions of each enzyme, from different bacterial species but cloned into *Bacillus subtilis* have slightly different characteristics which allow them to be used simultaneously, rather than in a stepwise process.

4.1.3 Brewing with genetically modified amylolytic yeast (Hammond, 1998)

The first stage of beer manufacture is the production of wort, which is subsequently fermented into beer by the addition of yeast. Wort is made by mixing ground malted barley with hot water and allowing the enzymes present to degrade the carbohydrates into a form which yeast can ferment. Because of the limited enzymatic activity of malted barley, and the limited fermentative versatility of brewing yeast, about 20% of the carbohydrate extracted into wort remains in the beer. The majority of this carbohydrate consists of dextrans, a type of starch.

To release this material into component carbohydrates for fermentation, a glucoamylase enzyme is used. GM yeasts (*Saccharomyces cerevisiae*) incorporating such an enzyme have now been produced.

At the end of fermentation and conditioning yeast is separated from beer by filtration. This process results in “bright beer”, which includes only small numbers of cells. Pasteurisation then removes all remaining viable yeasts from the beer.

4.1.4 Bakers yeast and hemicellulase (van Rooijen and Klaasen, 1998)

Several genetically modified baker’s yeast strains have been developed. The only modification to have been approved for food use is a yeast with increased expression of genes involved in maltose metabolism to promote carbon dioxide production.

Hemicellulases are enzymes used to break down hemicellulose to beta dextrans. A major subclass of hemicellulase enzymes are the xylanases. These enzymes are principally used in the baking industry, to break down the indigestible hemicellulose found in wheat flour, improve crumb softness and increase bread volume. Production of these enzymes from GM

sources is from *Bacillus subtilis* or *Aspergillus* spp., and the modification involves inserting additional copies of the native enzyme-producing gene to improve production efficiency.

4.1.5 Starter cultures for the dairy industry (Hill and Ross, 1998)

Starter cultures used in dairy fermentations typically belong to a family of bacteria collectively known as the lactic acid bacteria. The primary function of these bacteria is to convert lactose into lactic acid. This acidification has a preservative effect, and the drop in pH also results in loss of water from the curd as whey. In addition starters are responsible for the production of a variety of secondary metabolites, including a number of compounds which are necessary for flavour development.

Genetic manipulation of starter culture bacteria may include the following aims:

- Resistance to infection by phage (bacterial viruses)
- Probiotic cultures
- Production of antibacterial compounds as a further preservative measure;
- Specialised starters which overproduce certain flavour compounds.

However, the potential of these modifications has yet to be realised.

4.1.6 Chemicals produced from GM organisms

Riboflavin (vitamin B2) is a water soluble vitamin synthesised by plants and many micro-organisms but not produced by higher animals, and is an essential part of the diet. Chemically synthesised riboflavin is used widely in food, mainly for fortification, and the riboflavin produced by fermentation from GM *Bacillus subtilis* is used for the same purpose.

This novel food product was assessed by the UK ACNFP in 1996, and information is taken from their Annual Report for that year. The inserted genes were all of microbial origin. For safety of human food use, data on the purity of the derived riboflavin were considered. It was found that the product was at least as pure as the chemically derived product, and no DNA was present (destroyed in purification process).

4.2 **Approvals of GM micro-organisms and derived products for food use**

In the Draft Australia New Zealand Food Standards Code enzymes of microbial origin are listed in Standard 1.3.3 Table to Clause 17.

GM derived enzymes and other materials approved by the UK ACNFP are listed in Table 2. This listing is taken from a MAFF website:

<http://www.foodstandards.gov.uk/maff/archive/food/novel/cmocsaa.htm>

as well as ACNFP Annual Reports 1989 – 1999, and supplemented with information from the March 2000 Biotechnology Bulletin.

Table 2: UK ACNFP and Food Advisory Committee approved enzymes and chemicals derived from GM organisms

Enzyme/organism/chemical	Company	Approval Date
Bakers yeast (<i>Saccharomyces cerevisiae</i>)	Gist Brocades	March 1990
Chymosin from <i>Kluyveromyces lactis</i>	Gist Brocades	January 1991
Chymosin from <i>Aspergillus niger</i> var. <i>awamori</i>	Genencor	May 1991
Chymosin from <i>Escherichia coli</i> K-12	Pfizer	March 1992
Amylolytic yeast (<i>Saccharomyces cerevisiae</i>)	BRF International	February 1994
Hemicellulase from <i>Aspergillus niger</i> var. <i>awamori</i> Xylanase II	Quest International	June 1996
Hemicellulase from <i>Bacillus subtilis</i> – RH6000	Rohm GmbH	September 1996
Riboflavin from <i>Bacillus subtilis</i>	Hoffman La Roche	January 1997
Hemicellulase from <i>Aspergillus oryzae</i> Pentopan Mono	Novo Nordisk	September 1997
Hemicellulase from <i>Bacillus subtilis</i> Belase 210	Frimond SA.NV	August 1998

A wider range of enzymes from GM sources have been approved for use in Europe. Table 3 gives a list of these.

Table 3: Commercial food enzymes in the EC derived from GMOs*

Enzyme	GM source	Approvals
alpha Acetolactate decarboxylase	<i>Bacillus subtilis</i> containing <i>Bacillus brevis</i> gene	JECFA, France, Denmark
alpha Amylase	<i>Bacillus subtilis</i> containing <i>Bacillus stearothermophilus</i> gene	JECFA
alpha Amylase	<i>Bacillus subtilis</i> containing <i>Bacillus megaterium</i> gene	JECFA
alpha Amylase	<i>Bacillus licheniformis</i> (self cloned)	Belgium, Denmark, France, Greece, Netherlands
alpha Amylase	<i>Bacillus licheiformis</i> containing <i>Bacillus stearothermophilus</i> gene	France, Denmark
Catalase	<i>Aspergillus niger</i> containing <i>Aspergillus</i> gene	Reported to be GRAS under US legislation
Chymosin A	<i>Escherichia coli</i> containing calf gene	JECFA, United Kingdom, France
Chymosin B	<i>Aspergillus awamori</i> containing calf gene	JECFA, United Kingdom, France, Germany
Chymosin B	<i>Kluyveromyces lactisi</i> containing calf gene	JECFA, United Kingdom, France, Belgium, Denmark, Germany, Finland, Greece, Italy, Ireland, Netherlands, Norway, Spain
Cyclodextrin-glucosyl transferase	<i>Bacillus licheniformis</i> containing <i>Thermoanaerobacter</i> gene	Denmark
Beta Glucanase	<i>Bacillus subtilis</i> (<i>B. amyloliquefaciens</i>) containing <i>Bacillus</i> gene	France
Beta Glucanase	<i>Trichoderma reesi</i> containing <i>Trichoderma</i> gene	Being checked
Glucose isomerase	<i>Streptomyces lividens</i> containing <i>Actinoplanes</i> gene spp.	Not sold in UK
Glucose isomerase	<i>Streptomyces rubiginosus</i> containing <i>Streptomyces</i> gene	GRAS but not sold in UK
Glucose oxidase	<i>Aspergillus niger</i> containing <i>Aspergillus</i> gene	France
Hemicellulase (xylanase)	<i>Bacillus subtilis</i> containing <i>Bacillus</i> gene	United Kingdom, France, Netherlands
Lipase, triacylglycerol	<i>Aspergillus oryzae</i> containing <i>Rhizomucor</i> gene	Denmark
Lipase, triacylglycerol	<i>Aspergillus oryzae</i> containing <i>Thermomyces</i> gene	Belgium, Denmark, France, Netherlands

Enzyme	GM source	Approvals
Maltogenic amylase	<i>Bacillus subtilis</i> containing <i>Bacillus stearothermophilus</i> gene	JECFA, France, Belgium, Denmark, Greece, Netherlands
Pectinesterase	<i>Aspergillus oryzae</i> containing <i>Aspergillus aculeatus</i> gene	Denmark
Protease	<i>Aspergillus oryzae</i> containing <i>Rhizomucor</i> gene	France, Denmark
Protease	<i>Bacillus amyloliquifaciens</i> containing <i>Bacillus</i> gene	France
Protease	<i>Bacillus licheniformis</i> containing <i>Bacillus</i> gene	Being checked
Pullulanase	<i>Bacillus licheniformis</i> containing <i>Bacillus</i> gene	France
Pullulanase	<i>Klebsiella planticola</i> containing <i>Klebsiella</i> gene	
Xylanase	<i>A.spergillus oryzae</i> containing <i>Aspergillus</i> gene	Denmark
Xylanase	<i>A.spergillus oryzae</i> containing <i>Thermomyces</i> gene	United Kingdom, Belgium, Denmark, France, Netherlands
Xylanase	<i>A.spergillus niger</i> var. <i>awamori</i> containing <i>Aspergillus</i> gene	United Kingdom, Denmark, France, Netherlands
Xylanase	<i>A.spergillus niger</i> containing <i>Aspergillus</i> gene	France
Xylanase	<i>Bacillus subtilis</i> containing <i>Bacillus</i> gene	United Kingdom
Xylanase	<i>Bacillus licheniformis</i> containing <i>Bacillus</i> gene	Being checked
Xylanase	<i>Trichoderma reesi</i> containing <i>Trichoderma</i> gene	Netherlands

*Taken from UK MAFF website

<http://www.foodstandards.gov.uk/maff/archive/food/novel/enzyme.htm>

4.3 Enzymes for detergents

Large scale production of protease and lipase enzymes for use in laundry detergents is also being achieved via the use of genetic engineering. A US company, Genencor, has become the second largest industrial enzyme biotechnology company (after Novo Nordisk) through the production of enzymes from genetically modified bacteria. Enzymes are selected on the basis of their performance in different water types and temperatures. In the future the production of enzymes for use in body lotions and shampoos is planned, but issues associated with potential allergic reactions must be addressed first (Source: Forbes Magazine 21 February 2000 via AgNet).

5 LEGISLATIVE POSITION OF OVERSEAS GOVERNMENTS REGARDING GENETICALLY MODIFIED FOODS

5.1 Food Use Approvals

5.1.1 EU

In the EU the approval system for a novel food is governed by Regulation (EC) 258/97 concerning Novel Foods and Novel Food Ingredients, and takes the following course. For a full safety assessment, companies are required to submit an application to the appropriate Competent Authority in the Member State where they first intend to market the product (in the UK this is the Advisory Committee on Novel Foods and Processes (ACNFP)). A copy is also sent to the European Commission. Once a Competent Authority has accepted an application, it has 90 days in which to complete an initial safety assessment and forward it to the Commission. The Commission must then copy the assessment to other Member States for their comments, which have to be made within 60 days. If the initial assessment is favourable and no objections are raised by other Member States, then the food can be marketed. If objections are raised, or if the initial Member State considers that an additional assessment is required, the application will be referred to the EC Standing Committee for Foodstuffs for final agreement, consulting with the EC Standing Committee for Food as necessary (Source: ACNFP Annual Report 1999).

The other key piece of legislation related to GM foods is EC Directive 90/220 which controls the release of GMOs into the environment. This legislation is currently under review (details were given in the previous report from this project).

All requests to market GM crops in the EU are currently on hold, even though some of them have already passed EU safety tests. This is due to the current revision process for Environmental Directive 90/220. Several countries decided not to vote on individual requests until the revised directive is passed by the European Parliament. The Parliament has now given its approval to the revised version of Directive 90/220, which now has to be endorsed by the Council of Ministers (Source: European Commission press release 12 April 2000 via AgNet).

The male sterile chicory plant (*Radicchio rosso*) from Bejo Zaden has been waiting 6 years for approval, despite having been found to be safe by the EU Scientific Committee on Plants. Both this product, and the male sterile green hearted chicory also developed by Bejo Zaden, were submitted for approval to the Netherlands Competent Authority in 1998 and they asked the UK ACNFP for an opinion. Inadequate compositional data was identified as a problem by several Member States, and the European Commission asked the Scientific Committee for Food for an opinion. The company has since provided data addressing the concerns raised, but an opinion has yet to be issued by the Committee (Source: ACNFP Annual Report 1999).

A maize hybrid derived by crossing two previously approved GM lines (Monsanto's Maisgard MON810 and Roundup Ready GA21) has been considered by the UK ACNFP. The Advisory Committee, recognising that this application for a product derived from the crossing of two GM varieties raised new issues, asked Member States to also consider the information. The Committee felt that it should not be assumed that the hybrid would exhibit

the same properties as the parent lines. Therefore any product that was produced from the offspring of such a cross would, at this stage, need to be assessed on a case by case basis in the same way as any other product from a GM variety. This is in contrast with the approach in other countries, where clearance of a GM line also covers further crosses with other approved GM lines (Source: ACNFP 1999 Annual Report). An example is the cross between the MON810 and T25 corn lines by Pioneer Hi-Bred, which is covered by the separate approvals of these lines in the US, Japan and Canada, but is currently under consideration by the EU.

Zeneca has had to halt supply of its puree derived from ripening altered tomatoes into the EU, despite having marketed them in the UK for 3 years. The competent authority in the UK, the ACNFP, had reaffirmed its earlier conclusion that the processed tomatoes were safe, and the EU Directorate General 24 Scientific Committee on Foods then published its opinion on 23 September 1999, also that the products were safe. However a draft decision has yet to be made by the European Commission (Source: ACNFP Annual Report 1999).

The Dutch based company AVEBE was originally given permission by the Dutch government to grow a GM potato with altered starch content from 1994 to 1998, for the supply of starch to the textile and paper industries. However permission to grow the potatoes in the EU in 1996 for the purpose of using the processing waste in animal feed has been delayed. Feeding experiments were requested to assess the potential risk from the antibiotic resistance marker gene NPTIII (ankamycin resistance) included in the potato. It was considered possible that the gene could be transferred to gut microflora in animals, reducing the value of this antibiotic in fighting diseases such as tuberculosis. Meanwhile the 1999 crop had to be destroyed, and AVEBE is now suing the Dutch government for compensation (Source: Nature Biotechnology 2000; 18: 253-254).

The de facto moratorium on the approval of GM crops in the EU is expected to last until at least September 2000. Two varieties of rapeseed (AgrEvo) and one of fodder beet (Monsanto/Danisco/Plant Genetic Systems) were scheduled for a decision on marketing and sale in March, but the EU committee postponed a decision until later in the year (Source: Reuters 9 March 2000 via AgNet).

A bid to make genetically modified food producers liable for damaging the environment or public health, under “environmental liability laws” was rejected by the European Parliament in April (Source: Associated Press 12 April 2000 via AgNet).

5.1.2 France

Three GM corn strains developed by Novartis were approved for cultivation and importation for use in animal feed and in processed foods by the EU in 1997. However subsequently the French government declined to give final approval, citing concerns about the incorporated ampicillin resistance gene, and referred the matter to the European Court of Justice. This court delivered its ruling in March, saying that France did not have the right to suspend approval, but noted that member states could withhold final approval for putting a GM crop on the market if new information came to light showing it to be dangerous to human health. This seems to offer grounds for further disputes (Source: Reuters 21 March 2000, via AgNet, and Nature Biotechnology 2000; 18: 487).

5.1.3 Japan

Japan's Ministry of Health and Welfare has decided that all foods containing genetically modified ingredients will undergo mandatory tests for potential human health risks from April 2001. Previously such tests were carried out on a voluntary basis under a general regime, but now the Ministry will specify enzymes and proteins that should be tested for potential toxicity and allergenicity. The Ministry will also halt the evaluation of all new GM foods until the new testing regime is introduced. The Ministry also plans to introduce mandatory labelling of GM foods that have been approved. This parallels the decision by the Ministry of Agriculture, Forestry and Fisheries last year to introduce mandatory labelling of all food products containing detectable GM ingredients from April 2001. (Source: Nature Biotechnology 2000; 18: 131).

5.1.4 Germany

In a reversal of a safety license issued in January 1997, the German government has banned the general release of Novartis Seed's transgenic Bt maize 176. This occurred just prior to the anticipated approval of large scale planting of the crop. Under the EU Directive 90/220 (currently under revision) member states can deny permission for release of a transgenic organism within its borders on the basis of new scientific knowledge. The new material cited was a report indicating that additional research was required into the safety of antibiotic resistance genes. The same reason was used by the governments of Austria and Luxembourg to reject Bt 176 maize in 1997. Other work that was cited as required was to do with the effects of Bt toxin on non-target organisms and the effects of Bt toxin in soil (Source: Nature Biotechnology 2000; 18: 374). More recently the ban on this type of corn has been partially lifted, at least to the extent where field trials will no longer have to be destroyed (Source: German news item 7 April 2000 via AgNet).

5.1.5 Czechoslovakia

The Czech government has approved a draft law on the regulation of genetically modified material and products that will require state licensing of any GM product. Produce grown from GM material and products made from them will have to be submitted for approval to state authorities, and will have to be labelled. The draft law still needs to be approved by parliament (Source: Reuters 22 December 1999 via AgNet).

5.1.6 Portugal

Portugal's Agriculture Ministry has suspended until further notice production of two GM strains of corn registered for domestic planting. GM corn accounts for only 1,300 hectares of the plantings in Portugal (Source: Reuters 28 December via AgNet).

5.1.7 Sri Lanka

Sri Lanka has banned all imports of genetically modified foods. Sri Lanka does not produce any GM foods, but is a significant importer of wheat and sugar. (Source: Reuters 10 April 2000 via AgNet).

5.1.8 USA

The USDA has created a 38 member Advisory Committee on Agricultural Biotechnology to advise the Secretary for Agriculture on policy related to the creation, application, marketability, trade and use of biotechnology. The Committee has been formed for two years.

The FDA is responsible for the safety of all foods on the market that come from crops, including bioengineered plants, through a science based decision making process. In 1994 the FDA established a consultation process that helps ensure that foods developed using biotechnology methods meet the applicable safety standards. An interview with FDA Commissioner Jane Henney has been published which gives an overview of the FDA process. Although the consultation is voluntary, the FDA believes that all the bioengineered foods on the market have been through the consultative process. The point is made that the safety standards that the foods must meet are compulsory, whatever their means of development.

The full interview is available at:

http://www.biotechknowledge.com/showlib_us.php3?2770

In a major change in policy, the FDA announced in May that it will strengthen the premarket review of foods derived from biotechnology. The news release is at:

<http://www.fda.gov/bbs/topics/NEWS/NEW00726.html>

The move stems from public meetings held by the agency late in 1999. The FDA will publish a rule making it mandatory to notify the Agency at least four months in advance of the intention to market GM foods or animal feeds. The FDA will also require specific information to examine safety, labelling or adulteration issues, and this information will be made available to the public. The FDA also plans to develop labelling guidance to assist manufacturers who wish to voluntarily label their foods.

5.1.9 Canadian Biotechnology Advisory Committee

It was noted in the previous report from this project that a Canadian Biotechnology Advisory Committee (CBAC) had been established. The 21 member CBAC was established by the government of Canada to provide comprehensive independent expert advice on policy issues related to the ethical, social, regulatory, economic, scientific, environmental and health aspects of biotechnology, and reports to the Federal Biotechnology Ministerial Co-ordinating Committee.

CBAC have now released their work plan for 2000-2001. Five special projects will be undertaken in this period, one of which is the regulation of genetically modified foods.

Two key areas are to be covered, one on governance and regulation of the Canadian food regulatory system (its rationale, accountability, performance, transparency etc.) and the second on the social, ethical, legal, economic and environmental aspects of GM foods (benefits, identifying the issues etc.). The project will comprise a series of research studies

and reports from relevant expert bodies, development of public consultation documents (all to be completed around the end of 2000) and a final overarching report and recommendations by spring (May) 2001.

Further details are available at the CBAC website:

<http://cbac.gc.ca>

5.2 Rule Making by International Organisations

5.2.1 Biosafety Protocol

In January 2000, delegates from more than 130 countries to the UN sponsored Convention on Biological Diversity in Montreal negotiated a “Biosafety Protocol” for the regulation of international trade in recombinant DNA (rDNA) engineered plants, animals, and micro-organisms. The goal of the protocol is to ensure that the development, handling, transport, and field testing and use of rDNA engineered organisms into the environment are “undertaken in a manner that prevents or reduces the risks to biological diversity, taking also into account risks to human health”.

The Protocol is ratified ninety days after at least 50 countries have signed. It has now been signed by 68 countries (including New Zealand), principally during a conference of Parties to the United Nations Convention on Biological Diversity in Nairobi ending 26 May 2000 (Source: <http://usinfo.state.gov/topical/global/biosafe/00053001.htm>).

The full text of the agreement (“Cartagena Protocol on Biosafety”), as well as related material are available at:

<http://www.biodiv.org/biosafe/>

Useful fact sheets regarding the Protocol are available at:

<http://usinfo.state.gov/topical/global/biosafe/>

Key points are summarised in these points taken from a fact sheet prepared by the US Department of State:

What it Does:

- The Protocol establishes an internet-based "Biosafety Clearing-House" to help countries exchange scientific, technical, environmental and legal information about living modified organisms.
- It creates an advance informed agreement (AIA) procedure that in effect requires exporters to seek consent from importers before the first shipment of living modified organisms (LMOs) meant to be introduced into the environment (such as seeds for planting, fish for release, and micro-organisms for bioremediation).
- It requires bulk shipments of LMO commodities, such as corn or soybeans that are intended to be used as food, feed or for processing, to be accompanied by

documentation stating that such shipments "may contain" living modified organisms and are "not intended for intentional introduction into the environment."

- The Protocol establishes a process for considering more precise identification of LMO commodities in international trade.
- The Protocol includes a "savings clause" that makes clear the Parties' intent that the agreement does not alter the rights and obligations of governments under the WTO or other existing international agreements.
- It assists developing countries in building their capacity for managing modern biotechnology.

What It Does Not Do:

- The Protocol does not address food safety issues. Food safety is addressed by experts in other international fora.
- It does not require segregation of bulk shipments of commodities that may contain living modified organisms (LMOs).
- It does not change rights and obligations under the WTO or other international agreements in any way.
- It does not subject shipments of bulk commodities to the Protocol's AIA procedure, which would have significantly disrupted trade in bulk commodities and would have jeopardized food access, without commensurate benefit to the environment.
- It does not require detailed identification requirements for bulk commodity shipments. (Any such requirements will be subject to a further negotiation to be concluded no later than two years after the Protocol enters into force).
- The Protocol does not require consumer product labeling. The mandate of the Protocol was to address potential risks to biodiversity that may be presented by living modified organisms. Issues related to consumer preference were not part of this negotiation. The Protocol's requirement for documentation identifying bulk commodity shipments as "may contain LMOs", and as "not intended for direct introduction into the environment" will be accomplished through shipping documentation.

The Protocol provides countries the opportunity to obtain information before new biotechnology derived organisms are imported. It acknowledges each country's right to regulate bio-engineered organisms, subject to existing international obligations. It also creates a framework to help improve the capacity of developing countries to protect biodiversity.

Key Provisions of the Biosafety Protocol

a. Advance Informed Agreement (AIA) Procedure

- The Protocol's AIA procedure, in effect, requires an exporter to seek consent from an importing country prior to the first shipment of a living modified organism (LMO) intended for intentional introduction into the environment (e.g., seeds for planting, fish for release and micro-organisms for bioremediation).
- The procedure does not apply to LMO commodities that are intended for food, feed, or processing (e.g., corn, soy or cotton), to LMOs in transit, or to LMOs destined for

contained use (e.g., vials for scientific research). LMO commodities and LMOs destined for contained use are addressed under documentation.

- Importers are to make decisions on the import of LMOs intended for introduction into the environment based on a scientific risk assessment and within 270 days of notification of an intent to export.

a. Commodity Requirements/Biosafety Clearinghouse

- The agreement requires governments to provide the Biosafety Clearinghouse with information concerning any final decisions on the domestic use of an LMO commodity within 15 days of making a decision.

a. Documentation

- The agreement sets forth different shipping documentation requirements for different types of LMOs, which will be effective after the Protocol comes into force. Documentation accompanying shipments of:
- LMOs intended for intentional introduction into the environment (e.g., seeds for planting) must identify the shipment as containing LMOs along with the identity and relevant traits of the LMO;
- LMO commodities must indicate that the shipment "may contain" LMOs, that the shipment is not intended for intentional introduction into the environment, and specify a contact point for further information. The Protocol provides for a decision by the Parties to further elaborate detailed requirements for this purpose, including specification of the identity and any unique identification of the LMOs, no later than two years after the entry into force of the Protocol; and
- LMOs destined for contained use (e.g., for scientific or commercial research) must identify the shipment as containing LMOs.

a. Savings Clause

- Countries participating in the negotiation had no intention of using the Protocol to alter their existing international rights and obligations. Therefore the Protocol includes a savings clause which states: "This Protocol shall not be interpreted as implying a change in the rights and obligations of a Party under any existing international agreement."

a. Precaution

- The Protocol includes language that states: "Lack of scientific certainty due to insufficient relevant scientific information and knowledge regarding the extent of the potential adverse effects of a living modified organism on the conservation and sustainable use of biological diversity in the Party of import, taking also into account the risks to human health, shall not prevent that Party from taking a decision, as appropriate, with regard to the import of the LMO in question ... in order to avoid or minimize such potential adverse effects."
- The language acknowledges the role that precaution may serve during decision making. However, the language does not replace science-based decision-making, nor does it authorize decisions contrary to a country's WTO obligations.

a. Trade with non-parties

- The Protocol states that the "transboundary movement of (LMOs) between Parties and non-Parties shall be consistent with the objective of this Protocol."

Amongst the large amount of news coverage of the Biosafety Protocol, the following part of an editorial in *Nature* makes some salient points:

"The new protocol sets fairly comprehensive controls on the movement of living organisms, as well as much narrower ones for grain. Shipments of GM grain will have to be labelled as

such; but the labelling regime won't come into force until two years after the protocol does, which probably means 2003 or 2004. By then, the labelling issue will probably have been solved by market forces. In defining the circumstances in which importing countries can decline to accept GM organisms, the protocol draws a fine balance. It rejects the need for "scientific certainty" in order for a party to make such a decision, a move being described by some environmentalists as a triumph for the precautionary principle which, they say, is espoused here for the first time in an international treaty. But the treaty also requires importers to use scientific risk assessment, including cost-benefit analysis, to lay grounds for exclusion. On the face of it, allowing for labelling, even vague labelling, in three or four years' time, is a major concession by the United States and the agricultural biotechnology industry. This concession was surely made, in part, because of the knowledge that failure to reach any kind of agreement would augur very badly for international trade in GM organisms. But it was balanced by the protocol's own admission that it does not supersede parties' rights under the WTO. The WTO has enforcement mechanisms, where the new protocol has none."

(Source: Nature February 3 2000; 403: 467).

The Precautionary Principle (or Precautionary Approach as it is actually called in the Rio Convention on Biodiversity) has been the subject of much discussion. The European Commission on 2 February 2000 issued its own analysis of the principle:

http://europa.eu.int/comm/off/com/health_consumer/precaution_en.pdf

The summary states:

1. The issue of when and how to use the precautionary principle, both within the European Union and internationally, is giving rise to much debate, and to mixed, and sometimes contradictory views. Thus, decision-makers are constantly faced with the dilemma of balancing the freedom and rights of individuals, industry and organisations with the need to reduce the risk of adverse effects to the environment, human, animal or plant health. Therefore, finding the correct balance so that the proportionate, non-discriminatory, transparent and coherent actions can be taken, requires a structured decision-making process with detailed scientific and other objective information.
2. The Communication's fourfold aim is to:
 - outline the Commission's approach to using the precautionary principle,
 - establish Commission guidelines for applying it,
 - build a common understanding of how to assess, appraise, manage and communicate risks that science is not yet able to evaluate fully, and
 - avoid unwarranted recourse to the precautionary principle, as a disguised form of protectionism.It also seeks to provide an input to the ongoing debate on this issue, both within the Community and internationally.
3. The precautionary principle is not defined in the Treaty, which prescribes it only once - to protect the environment. But in practice, its scope is much wider, and specifically where preliminary objective scientific evaluation, indicates that there are reasonable

grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen for the Community. The Commission considers that the Community, like other WTO members, has the right to establish the level of protection - particularly of the environment, human, animal and plant health, - that it deems appropriate. Applying the precautionary principle is a key tenet of its policy, and the choices it makes to this end will continue to affect the views it defends internationally, on how this principle should be applied.

4. The precautionary principle should be considered within a structured approach to the analysis of risk which comprises three elements: risk assessment, risk management, risk communication. The precautionary principle is particularly relevant to the management of risk.

The precautionary principle, which is essentially used by decision-makers in the management of risk, should not be confused with the element of caution that scientists apply in their assessment of scientific data.

Recourse to the precautionary principle presupposes that potentially dangerous effects deriving from a phenomenon, product or process have been identified, and that scientific evaluation does not allow the risk to be determined with sufficient certainty.

The implementation of an approach based on the precautionary principle should start with a scientific evaluation, as complete as possible, and where possible, identifying at each stage the degree of scientific uncertainty.

5. Decision-makers need to be aware of the degree of uncertainty attached to the results of the evaluation of the available scientific information. Judging what is an "acceptable" level of risk for society is an eminently political responsibility. Decision-makers faced with an unacceptable risk, scientific uncertainty and public concerns have a duty to find answers.

Therefore, all these factors have to be taken into consideration. In some cases, the right answer may be not to act or at least not to introduce a binding legal measure. A wide range of initiatives is available in the case of action, going from a legally binding measure to a research project or a recommendation.

The decision-making procedure should be transparent and should involve as early as possible and to the extent reasonably possible all interested parties.

6. Where action is deemed necessary, measures based on the precautionary principle should be, inter alia:
 - proportional to the chosen level of protection,
 - non-discriminatory in their application,
 - consistent with similar measures already taken,

- based on an examination of the potential benefits and costs of action or lack of action (including, where appropriate and feasible, an economic cost/benefit analysis),
- subject to review, in the light of new scientific data, and
- capable of assigning responsibility for producing the scientific evidence necessary for a more comprehensive risk assessment.

Proportionality means tailoring measures to the chosen level of protection. Risk can rarely be reduced to zero, but incomplete risk assessments may greatly reduce the range of options open to risk managers. A total ban may not be a proportional response to a potential risk in all cases. However, in certain cases, it is the sole possible response to a given risk.

Non-discrimination means that comparable situations should not be treated differently, and that different situations should not be treated in the same way, unless there are objective grounds for doing so.

Consistency means that measures should be of comparable scope and nature to those already taken in equivalent areas in which all scientific data are available.

Examining costs and benefits entails comparing the overall cost to the Community of action and lack of action, in both the short and long term. This is not simply an economic cost-benefit analysis: its scope is much broader, and includes non-economic considerations, such as the efficacy of possible options and their acceptability to the public. In the conduct of such an examination, account should be taken of the general principle and the case law of the Court that the protection of health takes precedence over economic considerations.

Subject to review in the light of new scientific data, means measures based on the precautionary principle should be maintained so long as scientific information is incomplete or inconclusive, and the risk is still considered too high to be imposed on society, in view of chosen level of protection. Measures should be periodically reviewed in the light of scientific progress, and amended as necessary.

Assigning responsibility for producing scientific evidence is already a common consequence of these measures. Countries that impose a prior approval (marketing authorisation) requirement on products that they deem dangerous a priori reverse the burden of proving injury, by treating them as dangerous unless and until businesses do the scientific work necessary to demonstrate that they are safe. Where there is no prior authorisation procedure, it may be up to the user or to public authorities to demonstrate the nature of a danger and the level of risk of a product or process. In such cases, a specific precautionary measure might be taken to place the burden of proof upon the producer, manufacturer or importer, but this cannot be made a general rule.

This European Commission document has also been circulated by Codex (Document CX/GP 00/3-Add.3). A United States response to the document has also been distributed which

raises a number of points of concern in the form of questions to the Commission. This response is available at:

<http://www.fsis.usda.gov/OA/codex/confpaper.htm>

The 1992 Rio Declaration on Environment and Development describes the precautionary approach, including the phrase: "...lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation". This approach has been criticised as it appears to require that the new technology must be proven safe before it can be used (Miller and Conko, 2000). However it will be extremely difficult to prove complete safety for GM materials, especially in the long term.

5.2.2 Codex Ad Hoc Intergovernmental Task Force on Foods derived from Biotechnology

This new task force is intended to develop standards, guidelines and principles on foods derived from biotechnology or traits introduced into foods by biological methods by 2003. It met for the first time in Chiba, Japan on 14-17 March, 2000. The agenda addressed the following topics:

- the need to develop key overarching principles for safety evaluation of all foods derived from biotechnology;
- the need to establish more specific guidelines for risk assessment of specific foods with particular reference to plant products;
- the need for clear definitions for foods derived from biotechnology;
- the need to clarify the meaning and application of the concept of substantial equivalence;
- the need to review and establish a list of validated analytical methods for detecting and analysing genetically modified foods;
- the importance of labelling and other legitimate factors (relevant to consumer health protection and the promotion of fair practices in food trade) and the need to progress these issues through the relevant Codex Committees.

To facilitate the work of the Task Force a joint FAO/WHO Expert Consultation on Foods Derived From Biotechnology is to be held in Geneva from 29 May to 2 June 2000.

To progress the work of the Task Force, two working groups were established. These will:

1. Address issues of overarching principles for evaluation of safety and nutrition of foods derived from biotechnology as well as more specific guidelines for risk assessment, develop guidelines for transparency and participation of all interested groups in decision-making processes, address the issue of definitions.
2. Compile a list of analytical methods.

The Working Groups will meet in July, and Task Force as a whole is scheduled to meet again in March 2001.

Related Codex Committees are those on Food Labelling and General Principles. The Codex Committee on Food Labelling has produced draft recommendations for the labelling of foods

obtained through biotechnology (CX/FL/00/6), to be considered at a meeting in Canada 9-12 May 2000.

5.3 Labelling

5.3.1 European Union

The two European Commission Regulations related to the labelling of GM food products (discussed in the January 2000 report from this project) were adopted on 10 January 2000. Regulation 49/2000 amends Council Regulation No 1139/98 (requiring mandatory labelling of foods and food ingredients from GM soya and maize if DNA or protein are present) by setting a *de minimis* threshold for labelling of 1%, to cover adventitious contamination. The 1% threshold is applied at the level of each individual ingredient, and not the final food; therefore the level of GM material in the final food will be much lower. Regulation 50/2000 requires the labelling of foodstuffs and food ingredients containing additive and flavourings that have been genetically modified or have been produced from genetically modified organisms, provided they are not equivalent to their conventionally produced counterparts i.e. when they contain protein or DNA resulting from genetic modification.

A *de minimis* threshold for additives is planned. The European Commission is working on rules on the use of “GM free” labelling, and the “negative list” of highly processed food ingredients where no novel DNA or protein remains, and which do not therefore require labelling (Source: ACNFP Annual Report 1999)..

Both Regulations came into force on 10 April 2000.

Regulation 49/2000 is available at:

http://europa.eu.int/eur-lex/en/lif/dat/2000/en_300R0049.html

Regulation 50/2000 is available at:

http://europa.eu.int/eur-lex/en/lif/dat/2000/en_300R0050.html

5.3.2 South Africa

The South African Department of Health announced in January that it would introduce regulations this year for the labelling of genetically modified food (Source: Reuters 24 January 2000 via AgNet).

5.3.3 Mexico

The Mexican Senate has voted to require the labelling of foods that contain genetically modified ingredients. The measure must now be approved by the lower house of congress, the Chamber of Deputies, before going to the President for signature (Source: Associated Press 30 March 2000 via AgNet).

5.3.4 Labelling developments in the US

There appear to have been three separate bills introduced into the legislative process in the US, which would require the labelling of products as to their GM status. There are two bills introduced by Senator Barbara Boxer (S2080 and one other) and one from Representative Dennis Kucinich (HR3377). Although they are supported by consumer and environmentalist groups, a member of the Biotechnology Industry Organisation (BIO), an industry lobby group, suggested there was little momentum behind the legislation. It was also suggested that the revision of the proposed USDA standards for defining organic foods to specifically prohibit genetic engineering, may address much of the concern over labelling (Source; Nature Biotechnology 2000; 18: 37).

The labelling bill sponsored by Representative Dennis Kucinich (HR3377) will require the labelling of foods derived from GM crops as “Genetically engineered: United States government notice: This product contains genetically engineered material, or was produced with a genetically engineered material”. Foods would be labelled if they contained more than 0.1% GM ingredients (Source: Information Systems for Biotechnology News Report February 2000 via AgNet).

5.3.5 Japan

New guidelines for labelling of GM foods issued by the Japanese Ministry of Agriculture, Forestry and Fisheries allow food products containing soybeans to be labelled as free of genetically modified ingredients even if as much as 5% of the soy used is GM. No similar percentage limit has been issued for corn (Source: Dow Jones 7 February 2000, via AgNet).

5.3.6 Soy sauce labelling in Japan

In Japan the issue of labelling soy sauce has had consequences that may occur in other countries. At present soy sauce is intended to be exempt from labelling, as the protein and DNA from any GM ingredients do not survive the fermentation process. The large producers of soy sauce and the Japanese Soy Sauce Association in Japan have, until now, refrained from labelling for the presence or absence of GM ingredients until industry wide guidelines can be agreed. However at least one small producer has begun labelling their product as GM free, and has raw material analytical results from a laboratory to prove it. The soy sauce industry is unhappy with this move as it may force the industry as a whole to introduce labelling, thus raising prices. Further price rises may come if the industry has to move to GM free soybeans, instead of the preferred high protein beans currently obtained from the US (Source: Dow Jones, 27 December 1999, via AgNet).

5.3.7 Brazilian soybeans

To date GM soybeans have not been approved for commercial planting in Brazil, giving it status as a source of GM free soy in world markets. However it has been estimated that 13% or more of the soybeans grown in Brazil are GM, as a result of beans obtained from neighbouring Argentina, where the GM soybeans are widely used (Source: Dow Jones, 28 December 1999 via AgNet).

6 CURRENT DEVELOPMENTS

6.1 Resources

6.1.1 National Research Council Report on “Genetically Modified Pest-Protected Plants: Science and Regulation”

Publication of this major report in book form is still in progress, but a prepublication copy is available from:

<http://www.nap.edu/html/gmpp/>

The National Research Council was organised by the US National Academy of Sciences to associate the broad community of science and technology with the Academy’s purposes of furthering knowledge and advising the federal government.

This report follows two earlier related reports from the same organisation:

1987: “Introduction of Recombinant DNA-Engineered Organisms into the Environment”, which dealt with general principles concerning potential ecological risks in field testing.

1989: “Field Testing Genetically Modified Organisms: Framework for Decision”, which addressed the ecological risks of small-scale field testing of engineered organisms.

Both these reports are available on the National Academy website at:

<http://www.nap.edu>

Note that the new report largely considers transgenic pest protected crop varieties containing the *Bacillus thuringiensis* (*Bt*) gene, although many of the conclusions and recommendation are applicable to other categories of transgenic plants. In order to appreciate the scope and purpose of this new and substantial document the following is taken from the Executive Summary:

“In the past, the National Academy of Sciences (NAS) and National Research Council (NRC) have provided guidance to scientists, regulatory agencies, and the public concerning biotechnology and transgenic products. The NRC determined that there was a need for an overview of the current issues surrounding transgenic plants, in particular those engineered to resist pests. As a result, the NRC appointed and funded a committee in 1999 to conduct the study reported here. The committee was charged with the following task:

The committee will investigate risks and benefits of genetically modified pest-protected (GMPP) plants, and the Coordinated Framework for Regulation of Biotechnology (Coordinated Framework) affecting the use of these plants. The study will 1) review the principles of the NAS Council’s white paper, *Introduction of Recombinant DNA-Engineered Organisms into the Environment* (1987), for their continued scientific validity and assess their appropriateness for current decisions regarding GMPP plants, 2) review scientific data which address the risks and benefits of GMPP plants, 3) examine the existing and proposed

regulations in light of the identified risks and benefits, 4) examine existing and proposed regulations to qualitatively assess their consequences for research, development, and commercialisation of GMPP plants, and 5) provide recommendations to address the identified risks/benefits, and, if warranted, for the existing and proposed regulation of GMPP plants.

Note: The study does not address philosophical and social issues surrounding the use of genetic engineering in agriculture, food labelling, or international trade in genetically modified plants.”

6.1.2 Websites for Biotechnology

The “Information Systems for Biotechnology” organisation has published an annotated list of websites related to biotechnology, and covering information sources, discussion groups and patent information. The list is available from the AgNet archive for January 11, 2000 at:

<http://www.plant.uoguelph.ca/riskcomm/>

Three websites covering both background information and current events concerned with GM food have been located. The CropGen website is provided by a panel of UK scientists, who are funded by industry but operate independently. Their website is:

<http://www.cropgen.org>

The University of Reading has established the National Centre for Biotechnology Education, funded by charging for the courses it runs. Their website is mostly devoted to education resources, but also has a page with current events in GM food:

<http://134.225.167.114/NCBE/GMFOOD/menu.html>

Northern Light Technology, Inc., is a company providing Internet related services. They have put together a web site devoted to the subject of genetically modified foods, including current issues from sources that both support and oppose the technology.

<http://special.northernlight.com/gmfoods/>

6.1.3 Agricultural Biotechnology and the Poor

The proceedings of an international conference convened by the Consultative Group on International Agricultural Research (CGIAR) and the US National Academy of Sciences have been published and are available from:

<http://www.cgiar.org/biotech/rep0100/cpontos.htm>

The conference was held at the World Bank in Washington DC in October 1999. The proceedings include reports from a wide range of countries on their attitudes and use of plant biotechnology. There are also useful chapters on sustainable use of GM crops (particularly with reference to management of Bt toxin issues) and assessing and minimising the risk of allergenicity in GM crops.

6.1.4 Physicians and Scientists for Responsible Application of Science and Technology (PSRAST)

This organisation is a group of scientists concerned about conditions that have been hampering impartial comprehensive, interdisciplinary evaluation of the safety of new applications of science and technology. Their current focus is on GM foods, and they have aggregated a variety of concerns into a single report. This can be found at:

<http://psrast.org/>

6.1.5 Background on Bt toxins

A three part article on Bt toxins and their use in GM plants has been published in "Agrichemical and Environmental News", Issues 167, 168 and 169 (March, April, May 2000). The articles were written by an environmental toxicologist at Wisconsin State University, and cover the mode of action of the toxins, potential human health effects, and recent controversies over Monarch butterflies and soil accumulation. The journal's website is:

<http://www2.tricity.wsu.edu/aenews>

6.1.6 Information campaign on biotechnology

The US Council for Biotechnology, which consists of seven leading companies plus the Biotechnology Industry Organisation (BIO) have launched a multimedia campaign to provide information about agricultural biotechnology. The campaign will cost \$50 million. More information is available at the website:

<http://www.whybiotech.com/main.html>

6.1.7 British Government Website

In December 1999 the British Government launched a website dedicated to information about Biotechnology and GM Food. The website address is:

<http://www.gm-info.gov.uk/>

6.2 **Human Health**

6.2.1 US National Research Council Report: Human Health Effects

An overview of this report is given in Section 6.1.1. From the Executive Summary of this report, the following section deals specifically with human health effects:

"Potential Health and Ecological Impacts and Research Needs

Conventional pest-protected plants have substantially improved plant health and agricultural productivity and have often lessened the need for chemical pesticides. Transgenic pest-protected plants have the potential to make similar contributions, as has already been documented with transgenic pest-protected cotton. Human health and environmental benefits could arise from reductions in the application of chemical pesticides resulting from the commercial production of certain transgenic pest-protected plants. However, the relative risks and benefits will depend on the particular transgenic pest-protected plant in question.

Historically, pest-protected plants have rarely caused obvious health or environmental problems, but there is a potential for undesirable effects. Therefore, a major goal for further research and development of transgenic and conventional pest-protected plants should be to enhance agricultural productivity in ways that also foster more sustainable agricultural practices, enhance the preservation of biodiversity, and decrease the potential for health problems that could be associated with some types of pest-protected plants. Although the committee focused its discussions on transgenic pest-protected plants, many of the following recommendations for research and development also apply to conventional pest-protected plants.

Health Impacts and Research Needs

Health impacts that the committee considered fall into three general categories: allergenicity, toxicity, and pleiotropic¹ effects of genetic modifications.

The potential for allergenic responses to novel gene products was considered. Such responses have not been documented for commercialized transgenic pest-protected plants, although one incident has been documented at the research stage. Several indirect tests for allergenicity are available. For novel proteins, the most common methods involve analyzing the protein for its digestibility, estimating the level of protein expression and consumption, and assessing homology to known allergens. While these indirect tests can be good indicators of potential allergenicity, the development of more direct tests is highly desirable. Therefore, the committee recommends that

Priority should be given to the development of improved methods for identifying potential allergens in pest-protected plants, specifically, the development of tests with human immune-system endpoints and of more reliable animal models.

The committee reviewed data concerning toxicity testing and potential pleiotropic or secondary effects of genetic modification. The committee concluded that monitoring for pleiotropic changes in plant physiology and biochemistry during the development of pest-protected plants should be an important element of health-safety reviews, in addition to testing the toxicity of the introduced gene products. Although results of tests for changes in the levels of certain endogenous plant toxicants are presented during consultation with FDA, there is a lack of an extensive database on the natural levels of such compounds in both transgenic and conventional pest-protected plants. The committee recognizes the challenges associated with detecting changes in those compounds given insufficient analytical information, and therefore, recommends research to

¹ Defined as *simultaneous effects on more than one character of the organism*

Assess and enhance data on the baseline concentrations of plant compounds of potential dietary or other toxicological concern, and determine how concentrations of these compounds may vary depending on the genetic background of the plant and environmental conditions.

In addition to the above research, the committee recommends that

The EPA, FDA, and USDA collaborate on the establishment of a database for natural plant compounds of potential dietary or other toxicological concern.

The committee recognizes that a significant amount of time and resources will be needed to establish such a database, given the complexity of these plant compounds.

For some novel pest-protectants developed for future commercialization, long term toxicity testing may be warranted. Tests which involve feeding of large quantities of pest-protected plants to animals have limitations, and the results can be difficult to interpret especially when the animal's natural diet does not consist of the type and quantities of the plant being tested. Therefore, the committee recommends research to

Examine whether long term feeding of transgenic pest-protected plants to animals whose natural diets consist of the quantities and type of plant material being tested (for example, grain or forage crops fed to livestock) could be a useful method for assessing potential human health impacts.

In conclusion, although there is the potential for the adverse health effects discussed in this section,

The committee is not aware of any evidence that foods on the market are unsafe to eat as a result of genetic modification.”

6.2.2 Cauliflower mosaic virus

In the previous issue of this report websites were given relevant to a report suggesting that this commonly used promotor could undergo horizontal gene transfer and cause disastrous human health effects by reactivating dormant viruses. This suggestion was firmly rebutted by a number of virologists. An useful overview of the controversy has been published (Hodgson, 2000)

6.2.3 GM food tests on humans

It has been reported that the UK Ministry of Agriculture Fisheries and Food are to fund trials in which GM foods are given to hospital patients who have undergone an unrelated operation (ileostomy) which allows access to their gastrointestinal tract. The purpose will be to examine whether genes from GM food survive long enough to transfer to bacteria in the gut. The trials will be held in Newcastle and will start next year (Source: BINAS Online May 2000).

6.2.4 Gene transfer to gut bacteria

Results from halfway through a research project to examine the potential transfer of antibiotic resistant genes to gut microflora in chickens have been announced. The research at the University of Leeds was reported at a meeting of the British Society of Animal Science. The research used the gene “*bla*”, which has been inserted into maize and confers ampicillin resistance. The maize was used as chicken feed, and after 5 days there was no evidence that the gut bacteria had taken up and activated the gene. The same result was seen when the gene was included in the animal diet in the form of a plasmid, which are more likely to be taken up by bacteria than genomic DNA (Source: New Scientist 25 March 2000).

Preliminary results from a three year study at the University of Jena in Germany have found that the herbicide resistant genes used to modify oilseed rape had transferred to bacteria and yeast living inside honey bees. This transfer was rare, but detectable. The scientist leading the project, Professor Kaatz, was reluctant to talk about the work until it had been officially published and reviewed (Source: Agence France Presse 28 May 2000 via AgNet).

6.2.5 New crops in development with properties relevant to human health

Note that this collation of information includes material reported in the scientific literature and biotechnology press. It will not be comprehensive, and does not include many new crops being worked on by commercial companies.

6.2.5.1 *Rice*

In the previous report from this project details were given of the development of rice which produces beta carotene, the precursor to vitamin A. The formal scientific report for this work has now been published (Ye et al., 2000). A collaborative arrangement has been agreed between the developers of the rice, and the biotechnology company Zeneca, to assist in the nutritional and safety testing, and the regulatory approvals process (Source: <http://www.ZenecaAg.com>).

6.2.5.2 *Soybeans*

The health benefits of the consumption of soybeans has been attributed in part to the presence of isoflavones, which occur almost exclusively in soybeans and other legumes (Mann and Truswell, 1999). There is interest in increasing the isoflavone level in soybeans, as well as potentially engineering other plants to produce these compounds. Progress towards this goal has been made by identifying the previously unidentified isoflavone synthase gene from soybeans and a number of other legume plants, and successfully introducing the gene into the non-leguminous plant *Arabidopsis* (Jung et al., 2000).

6.2.5.3 *Potatoes*

Improved nutrition from potatoes was the aim of introducing a gene from *Amaranthus hypochondriacus* (a type of spinach) into potato. The protein used was non allergenic, and conformed to World Health Organisation standards for optimal human nutrition. The total

protein content and essential amino acid content of tubers from the transgenic potato was increased (Chakraborty et al., 2000).

6.2.6 GM contamination in rapeseed/canola in Europe

Advanta Seeds in the United Kingdom has told the UK government that some of its conventional (Hyola 38 brand) rapeseed sold and sown in the EU and the UK during the past 2 years was actually contaminated with GM rapeseed, to a level of about 1%. No health or environmental risks were likely, but the event has tarnished the GM industry in Europe. The UK MAFF Plants and Seeds Division has further information at:

<http://www.maff.gov.uk/planth/pvs/pvsd.htm>

The contaminating GM material (RT73) is authorised to be planted in the EU for field testing, but not commercial marketing.

The seeds originally came from Canada, and the contamination is believed to have occurred through cross pollination with a GM rapeseed crop growing in a nearby field. Approximately 600 farms in the UK are believed to have planted the seed, as have farms in Sweden, France and Germany. About 1500 and 750 acres of land were believed to be involved in France and Germany respectively. The total rapeseed area in France is about 3.1 million acres (Source: Reuters 17, 18 and 19 May 2000 via AgNet).

6.2.7 Transgenic fish and the “Trojan” gene: first GM animal for human food?

The US Food and Drug Administration (FDA) are currently reviewing an application from A/F Protein in Massachusetts for genetically modified salmon. These fish have been engineered to grow faster and consume less feed than their wild counterparts, and are likely to be the first GM animals to reach the marketplace. The company has taken a gene promoter from another fish, the ocean pout, and inserted it into the Atlantic salmon. This causes the salmon to express growth hormone from its liver, in addition to the normal pituitary gland. The fish grow to full size more quickly and consume 20-25% less food (Source: Nature Biotechnology 2000; 18: 143).

A complication for this application arises from a study at Purdue University which examined Japanese medaka fish that were genetically modified to produce human growth hormone (Muir and Howard, 1999). These fish matured faster and carried more eggs than their unmodified counterparts. Due to their larger size for their age, the male fish attracted four times as many mates as smaller unmodified fish. However only two thirds of the modified fish survived to reproductive age. These data were used in a computer model for the interaction between GM fish and their wild counterparts. The model predicted that a transgene introduced into a natural population by a small number of transgenic fish will spread as a result of enhanced mating advantage, but the reduced viability of offspring will cause eventual local extinction of both populations. The study recommended that such risks should be evaluated with each new transgenic animal before release.

6.2.8 Bt toxin Cry9C

The US Environmental Protection Agency (EPA) is responsible for assessing the safety of pesticides, which includes the Bt toxins used in GM plants. The EPA has been assessing the potential for allergenicity of the Cry9C protein from *Bacillus thuringiensis* subspecies *tolworthi*. This particular Bt toxin is unusual in that it is more stable to proteolytic digestion in the gut than other forms of Bt toxin (Cry1 and Cry2), which are rapidly degraded. As stability to digestion is a trigger for allergenicity assessment, the EPA has put out a consultation document, and requested data from the company applying for approval, AgrEvo. The background document is available at:

http://www.epa.gov/oppbppd1/biopesticides/cry9c/cry9c-peer_review.htm

Note that this Bt toxin is present in Starlink corn from AgrEvo, which has been approved by the Food and Drug Administration, which is responsible for food safety. However the corn is restricted to being used only for animal feed or being processed into products such as corn syrup which present no dietary exposure to the Cry9C protein (John Kough, EPA, personal communication).

6.3 Consumer Issues

6.3.1 OECD Conference in Edinburgh

The OECD conference held in Edinburgh from 28 February to 1 March 2000 was titled: “GM Food Safety: Facts, Uncertainties, and Assessment”. It was attended by 400 invited delegates from 25 countries. The aim was to be inclusive, encouraging a wide diversity of views. The principal conclusions below are taken from the Chairman’s Report:

“Food safety

- Worldwide, many people are eating GM foods (especially in North America and China) with no adverse effects on human health having been reported in the peer reviewed scientific literature.
- There could, in theory, be long-term effects on human health that have not yet been detected because GM foods have been available for less than ten years.

Decision-making, assessment and choice

- In the future, policy decisions about GM food, as well as the assessment of their safety, should be more inclusive and open than has typically been the case in the past. People want to know how decisions have been reached and to be consulted. This process will help remove suspicion.
- Having said this, there was no clear conclusion on how attitudes and beliefs that might become apparent as a result of consultation should be incorporated into the assessment and communication of GM food safety. For many, safety assessment remains an essentially technical and scientific process.
- Consumers should be allowed to choose. Labelling of GM foods is important, although there was no agreement on how far this should extend (e.g. to GM derivatives? To animals fed on GM?). It is important also to note that the labelling applies to the process

by which organisms are created and not the food product, which in many cases is identical to its conventional counterpart.

The assessment of GM food safety

- The assessment of the safety of any novel food, including GM food, involves a variety of kinds of evidence. One commonly used tool is the concept of “substantial equivalence”. The essence of this idea is that a comparison between the novel food and one already in the diet provides the basis for asking questions about the safety of the novel product. Substantial equivalence is not a quantitative criterion or a hurdle, but a framework for thinking. It is continually modified and updated, but it is timely now, after six years of using the tool, to undertake a more detailed review.
- On two more technical issues: (a) there is no clear agreement about the importance of animal feeding trials (other than toxicity trials) in assessing the safety of novel foods, including GM foods; (b) The methods for testing toxicity and allergenicity of GM foods need re-examination.
- Existing international bodies are working to achieve consistent standards and criteria for the assessment of food safety, and this is to be applauded. The precautionary principle is now beginning to be discussed internationally in relation to food safety, but it has not yet been translated into an agreed operational form.

GM technology in developing and developed countries

- The majority of speakers from developing countries stressed the crucial importance of GM technology as part of the armoury for feeding their population in the future. In China, with 20% of the world’s population and 7% of the land surface, GM is already playing a major role in food production, and its importance was also emphasised by speakers from Africa and Latin America. However, the view was also expressed that the future application of GM technology in developing countries should be more explicitly tuned to the needs of local people rather than of multinational corporations.
- In light of this last comment, GM technology for the developing world should be carried forward through a mixture of public and private funding.
- Whilst it is essential that standards of safety assessment should be consistent and high throughout the world, the strongly expressed demand for GM technology in developing countries casts substantial doubt on proposals for a worldwide moratorium made by some participants.
- The first generation of GM crops and foods are perceived as having brought little direct benefit to consumers in developed countries, but this may well change as new products appear with direct quality, health or price benefits.

Concerns about GM other than food safety

- The principal concerns of the opponents of GM related less to food safety than to the broader question of why GM food is being produced at all. Most developing country speakers argued forcefully that GM technology is an essential part of their future food production, but this was rejected by some NGO speakers from Europe and North America. They argued, instead, for solving world food shortage by redistribution, better prevention of loss during storage and so on. They also pointed out, as did some

developing country participants, that citizen engagement in decision-making and discussion should be improved in developing countries.

- A second concern about GM agriculture was the potential environmental impact. Although there have been many field trials and, in some parts of the world, large-scale commercial planting of GM crops, there has been insufficient work to fully assess environmental impacts, especially in the biodiversity-rich tropics.”

The principal outcome of the conference was the recommendation by the Chairman (Sir John Krebs) that an international forum be set up to continue the process started in Edinburgh. The aim of such a forum would be to provide governments with a state of the art assessment of scientific knowledge about GM technology, and to set this assessment in the context of broader concerns of society. The model suggested for such a body was the Intergovernmental Panel on Climate Change. This proposal will be taken to the G8 summit in Japan in July.

Further information is available from:

<http://www.oecd.org/subject/biotech/edinburgh.htm>

6.4 Trends in GM Food Use in Industry

6.4.1 Supermarkets in the US begin to ban GM ingredients

Two supermarket chains in the United States, Whole Foods Market Inc., and Wild Oats Markets Inc., have announced that they will ban genetically modified ingredients from their hundreds of private label products. However, the Grocery Manufacturers Association of America considers that it is easier for these companies, who produce mostly organic products, from which GM ingredients are banned anyway, to adopt a GM free policy. For most supermarket chains taking this approach would affect too many products and be too costly (Source: Los Angeles Times 31 December 1999 via AgNet).

The US snack food maker Frito Lay has asked its contract growers to grow corn that has not been genetically modified. Frito Lay is a division of PepsiCo Inc and makes Dorito and Tostitos corn chips (Source: Los Angeles Times 28 January 2000, via AgNet).

6.4.2 Tesco

In addition to its ban on GM ingredients in animal feed given to animals intended for meat sales, Tesco has also announced that fruit and vegetables from its suppliers must not come from sites used for testing genetically modified crops. This announcement was made at the same time as the UK government was proposing farm scale trials of three GM crops on 60 sites (Source: PA News 6 January 2000 via AgNet).

6.4.3 European sectors of multinational companies avoid GM ingredients

Several parts of the multinational food company Nestle have announced that they will stop using ingredients from genetically modified plants. These include Nestle operations in France, Austria, Germany, Spain, Italy and the UK (and more recently Hong Kong). However Nestle in the US has not made such an announcement, and admits its foods do contain some GM ingredients. In addition to Nestle, Kraft, McDonalds, Quaker, M and M Bars, Dannon, Pillsbury, and Burger King have announced that they will not use GM

ingredients in their products sold in Europe. Kellogg's has announced that cereals sold in Britain are made from non-GMO corn (Source: Greenpeace press release 7 January 2000 via AgNet).

In early 2000, Friends of the Earth contacted 21 of the world's top food and drink companies and asked them for their policy on GMO ingredients and derivatives in the food they sold in Europe. Sixteen said that they sourced ingredients from GMO free crops. Companies that said they currently source all their ingredients from GMO free crops were Pepsi Cola, Coca Cola, Heinz, Mars, Danone, Kellogg's, Campbell Foods, Cadbury Schweppes and Kraft/Jacobs/Suchard. Nestle said that it supplied food made from GMO free crops as far as practically possible. Unilever said it was moving to a new system in Europe where hardly any GMO ingredients will be used (Source: Friends of the Earth press release at: <http://www.foe.co.uk/pubsinfo/infoteam/pressrel/2000/20000307120054.html> via AgNet).

6.4.4 Seagrams

The large distilling company Seagrams, based in Canada, has told the farmers supplying corn for its spirits products, that it will no longer accept GM varieties (Source: Toronto Star 9 February 2000 via AgNet).

6.4.5 Shareholder led rejections of GM ingredients

Proposals by shareholders to eliminate GM ingredients from products made by food companies have been introduced for a number of US food producers. Such a move for Kelloggs was unsuccessful in May. The company is in the process of removing biotech ingredients from its products in Europe and Australia, but does not intend doing so in the US (Source: Newswire 1 May 2000 via AgNet). A similar proposal for Pepsico, related to banning GM corn derived high fructose corn syrup, was also unsuccessful (Source: Reuters 3 May 2000 via AgNet).

6.5 Tracing GM Foods, Integrity Systems

6.5.1 GM Foods in international trade

Information on this topic is difficult to obtain, and no single source is easily available. The following has been obtained from a variety of sources.

Japan imports approximately 5 million tonnes, or 80% of the soybeans used in food processing, from the US. In response to the announcement of mandatory labelling of GM foods from 2001, about 20% of these imports will be switched to non-GM soybeans during 2000. Some of the non GM soybeans will come from contract growers in the US, while others will be obtained from China (Source: Dow Jones 7 January 2000 via AgNet).

Korea will import 105,000 tonnes of non-GM corn from Inner Mongolia this year. This source was preferred as being of good quality as well as non-GM, and even though a premium was paid (\$104.50 per tonne) over poorer quality Chinese corn (\$103.50 per tonne), this was still cheaper than imported US corn (\$118-9 per tonne) (Source: Reuters 21 February 2000 via AgNet).

Corn and soy exports from the US have been decreased due to resistance to GM foods. In 1997-1998 corn exports from the US to Europe stood at 2 million tons. In marketing year 1998-1999 the amount was 137,000 tons. Soybeans dropped from 11 million tons in 1998 to 6 million tons in 1999. The loss to the American farmer has been estimated as over \$1 billion (Source: American Corn Growers Association press release 12 March 2000 via AgNet). Europe buys 25% of the US soybean crop, worth \$2.6 billion in good years. Purchases dropped, to \$1 billion in 1998, according to the United States Department of Agriculture (Source: New York Times, 14 March 2000 via AgNet).

A review of the prospects for corn and soybean trading by the US has been published by the United States Department of Agriculture Economic Research Service in their Agricultural Outlook journal (Volume AGO270 April 2000). In 1998/99 US share of the global corn trade

was about two thirds, which indicates that importers cannot easily satisfy demand from alternative sources.

The EU imports about 16 million tons of soybeans and 19 million tons of soymeal annually, with most being used for animal feed. About 1 million tons are used for human food.

The full report is available at:

<http://usda.mannlib.cornell.edu/reports/erssor/economics/ao-bb/2000/ao270.as>

6.6 Agricultural Issues

6.6.1 Commercialised Transgenic Crops 1999: ISAAA

The International Service for the Acquisition of Agri-Biotech Applications (ISAAA) collates information on commercialised transgenic crops. Their report for 1999 has yet to be published, but a preview is available for subscribers to the report.

Tables 4-7 have been updated to add the 1999 ISAAA data. As a reference point Table 4 includes the total global acreage for these crops, derived from the FAO Production Yearbook Vol. 51 1997.

As shown in Table 4, the amount of land planted with GM crops increased by approximately 44% in 1999. The information now includes China, in which an estimated 750,000 acres, principally Bt cotton, were grown in 1999. The US continues to have the highest amount of land planted with transgenic crops. Seven transgenic crops were grown commercially in twelve countries in 1999, three of which, Portugal, Rumania and the Ukraine, grew transgenic crops for the first time (note that Portugal has since withdrawn approval for GM commercial plantings).

Table 4: Global acreage of transgenic crops and total global acres by crop

Crop	GM acres x 10 ⁶			1997 total global acres x 10 ⁶ (% GM in 1999 - estimated*)
	1997	1998	1999	
Soybean	12.8	36.3	54.0	146.8 (36.8)
Corn	8.0	20.8	27.8	291.4 (9.5)
Cotton	3.5	6.3	9.3	73.1 (12.7)
Rapeseed/Canola	3.0	6.0	8.5	43.5 (19.5) (rapeseed)
Potato	<0.3	<0.3	<0.3	37.0 (<0.8)
Total**	27.5	69.5	98.6	591.8 (16.7)

* Calculated using number of acres of GM crops in 1999 and total number of acres of that crop in 1997; assumes total global acres of that crop has not changed significantly from 1997 to 1999

** Due to minor crops, rounding and conversion factors totals may not be exact.

Table 5: Global acreage of transgenic crops by trait

Trait	1997 acres x 10 ⁶	1998 acres x 10 ⁶	1999 acres x 10 ⁶
Herbicide resistance	17.3	49.5	70.2
Insect resistance	10.0	19.3	22.2
Insect/herbicide resistance	<0.3	0.8	7.2
Virus resistance/other	<0.3	<0.3	<0.3

Table 6: Global dominant transgenic crops by crop

Crop	% of total in 1998	% of total in 1999
Herbicide resistant soybean	52	54
Insect resistant corn	24	19
Herbicide resistant rapeseed/canola	9	9
Insect/herbicide resistant cotton	9	5
Herbicide resistant corn	6	4

Table 7: Global acreage of transgenic crops by country

Country	1997 acres x 10 ⁶	1998 acres x 10 ⁶	1999 acres x 10 ⁶
USA	20.3	51.3	71.7
Argentina	3.5	10.8	16.7
Canada	3.3	7.0	10.0
Australia	0.3	0.3	0.3
China	NA	NA	0.75
South Africa	NA	NA	0.3
Mexico	<0.3	0.3	0.3

NA = not available

6.6.2 GM plantings in the US decrease for 2000

In January 2000, Reuters conducted a straw poll of 400 US farmers at the annual meeting of the largest US farm organisation, the American Farm Bureau Federation. These farmers planned reductions in their planting of GM crops, ranging from 15% for Roundup Ready soybeans, to 26% for Bt cotton. The only exception to the overall decline was a 5% increase in planting of Roundup Ready cotton. The main reason given was European Union resistance to bioengineered foods (Source: Reuters 13 January 2000 via AgNet).

Another survey, this time by the American Corn Growers Association (ACGA) shows that those growers who planted GM corn in 1999 will reduce their plantings by 16% in 2000. The survey contacted 582 growers in 17 states. More information can be found at the ACGA website:

<http://www.acga.org>

(Source: ACGA press release via AgNet)

A survey of farmers by the USDA released in April 2000 showed that they intend reducing the area of GM crops planted. GM corn area was expected to drop from 33% to 25%. Farmers in eight major soy producing states will reduce the area planted with GM varieties from 57% to 52%. Farmers in five major cotton producing states said they would reduce the area planted with GM varieties from 55% to 48% in 1999. The survey is available from:

<http://usda.mannlib.cornell.edu/reports/nassr/field/pcp-bbp/pspl0300.txt>

and the Economic Research Service press release is at:

<http://usda.mannlib.cornell.edu/reports/erssor/economics/ao-bb/2000/ao271f.a>

6.6.3 GM crop plantings miscellaneous

Monsanto has announced that it is hoping to launch genetically modified Bt corn as a commercial crop in China in 2001, following three years of field trials to determine the level of increased yield. However China is also developing its own Bt corn, in addition to its own Bt cotton, which is already competing with Monsanto's Bt cotton as a commercial crop (Source: Reuters 17 January 2000 via AgNet).

In China, GM seed use is growing rapidly, though volumes remain small at present. Only 750,000 acres of GM crops were planted in 1999, but China's scientific community is hoping that half of China's agricultural production will be GM within 10 years. So far six commercial licenses for GM crops have been granted by China's Ministry of Agriculture: two for tomatoes, two for cotton, one for sweet pepper and one for petunias. Only one licence has gone to a foreign company, Monsanto's bollworm resistant cotton (Source: Far Eastern Economic Review 20 April 2000 via AgNet).

Although worldwide GM cotton is not a dominant crop, it has become well established in the US. Monsanto claims that US plantings of insect resistant or herbicide tolerant cotton has risen from 1.8 million acres in 1996, to 7 million acres (55% of total) in 1999 (Source: Dow Jones 8 February 2000 via AgNet).

Russian scientists have announced field trials of a GM potato resistant to the Colorado potato beetle. The scientists are also working on GM varieties of sunflower, rice and wheat (Source: Bridge News 11 February 2000 via AgNet).

Soybean crops occupy the largest area of agricultural land in Argentina, comprising approximately 21 million acres in 1999-2000, up from approximately 17 million acres in 1996-97. In the early to mid 1990s the yields were approximately 12.5 million tonnes, compared to approximately 19.5 million tonnes today. Between 70 and 90 % of the crop is believed to be GM. Part of the increased yield has been attributed to the use of GM soy (Source: Dow Jones 21 January and 17 February 2000, via AgNet).

6.6.4 UK field trials

The farm scale trials of GM crops announced last year by the UK Department of Environment, Transport and the Regions are moving ahead. Up to 80 farm scale trials have been planned, of GM corn, beet and oilseed rape, with about 30 scheduled to commence on March 30. The trials are set to continue until 2003, and will examine effects on weeds and insects, by comparing parts of each field, each planted with a GM and non-GM variety (Source: PA News 17 March 2000, via AgNet).

6.6.5 Bt toxin and the Monarch butterfly

An overview of research being conducted into the issue of effects on non-target insects such as the Monarch butterfly has been assembled by Monsanto. It is available at:

<http://www.fooddialogue.com/monarch/index.html>

6.6.6 Bt toxin in soil

In a preliminary report in the December issue of Nature, a laboratory study has found that root exudates from Bt corn contain biologically active Bt toxin and that the toxin retains its activity up to 25 days after release from the plant (Saxena et al., 1999). Previous work by these scientists had shown that in laboratory situations, Bt toxins were bound to clays or humic acids in soil, and this protected them from microbial degradation (Crecchio and Stotzky, 1998). They also found that the insecticidal activity of the toxins was not affected by being bound to the soil particles, as long as the soil pH was acidic rather than neutral (Tapp and Stotzky, 1998).

The concern from these results is that Bt toxins may accumulate in soil during continuous cultivation of Bt corn, and so have unintended effects on non-target organisms in the soil. However these results are preliminary, and (as with the Monarch butterfly study) research under field conditions will need to be undertaken to assess the risk. No human health implications have been identified from these results (Source: Information Systems for Biotechnology News Report February 2000 via AgNet).

6.6.7 Resistance control measures for planting Bt corn in USA

The US Environmental Protection Agency has released new rules for the planting of Bt corn in the 2000 season. These will require the planting of at least 20% non-Bt corn (in areas known as refugia) in the fields in corn growing areas, and at least 50% non-Bt corn in crops grown in areas that also produce cotton (the higher area set aside for refugia in cotton growing areas is due to the fact that corn earworms feed on both corn and cotton). These refugia must be planted as specific blocks, or around the edges of fields. The EPA has also requested monitoring data on insect resistance, and effects on non-target species, such as Lepidoptera (Source: Nature Biotechnology 2000; 18: 133 and letters to biotechnology companies at the EPA website e.g.

http://www.epa.gov/oppbppd1/biopesticides/otherdocs/bt_corn_ltr_monsanto.htm

6.6.8 New GM materials in development with properties relevant to agriculture

Note that this collation of information includes material reported in the scientific literature and biotechnology press. It will not be comprehensive, and does not include many new crops being worked on by commercial companies.

6.6.8.1 *Rice with increased yields*

At a workshop organised by the International Rice Research Institute in the Philippines in late 1999, details of a joint US-Japanese project to redesign rice photosynthesis were announced. By transferring genes with an improved mechanism for the process of photosynthesis from maize to rice the researchers have produced initial results that suggest that rice yields could be increased by up to 20%. Tropical species such as maize, sorghum, and sugarcane, which are known as C4 plants, have evolved a more efficient photosynthetic mechanism than so-called C3 plants such as rice, barley and wheat. Rice already contains all of the genes responsible for C4 photosynthesis. The problem is that they are not switched on and regulated as they are in maize (Source: International Rice Research Institute press release).

6.6.8.2 *Tobacco resistant to herbicide Acifluorfen*

The first group of herbicide resistant crops included those with resistance to glyphosate, glufosinate, and bromoxynil. These three herbicides represent three different modes of action, respectively disrupting aromatic amino acid biosynthesis, ammonium assimilation, and photosynthesis. To achieve these resistant crops, two strategies have been employed. For glyphosate resistance, crops were transformed with a bacterial version of the enzyme targeted by glyphosate, such that it maintains catalytic activity without allowing the herbicide to bind. Resistance to glufosinate and bromoxynil, by contrast, is based on the introduction of genes that enhance metabolism of the herbicides, converting the active compounds to products that are not toxic to the crop.

Resistance to the herbicide acifluorfen has been achieved by a new mechanism, overexpression of the target enzyme (Lermontova and Grimm, 2000). This enables the plants to withstand applications of the herbicide which destroys weeds.

6.6.8.3 *New corn variety resistant to corn rootworm complex*

Monsanto has applied to the Environmental Protection Agency for approval to field test and market a new line of GM corn. The plant carries a gene that produces a version of the Bt toxin that kills one of the toughest insect pests of corn, the corn rootworm complex, which comprises the larvae of three related beetle species (Source: Science February 25 2000; 287: 1399). This version of the Bt toxin is Cry3Bb, from *Bacillus thuringiensis* subsp. tenebrionis, and is different to those already used to confer resistance to the European corn borer (Cry1 and Cry2 versions).

Further information is available from:

<http://www.biotech-info.net/rootworm.html>

6.6.8.4 Antifungal plants

Fungal infections are a common cause of yield loss in crop plants, and may also cause the production of mycotoxins with human health effects. Achieving antifungal activity through genetic modification is inhibited by the shortage of genetically based anti-fungal defence mechanisms. One mechanism that has been found is from fungi infected with viruses. The viruses infecting the fungi produce antifungal proteins, so-called killing proteins, which inhibit the growth of sensitive cells, including other fungi of the same species but different subtypes. The viral host species is unaffected.

A gene encoding one of these killer proteins has been successfully incorporated into wheat, with expression of the protein and demonstrated antifungal activity of the resulting plants (Clausen et al., 2000).

6.6.9 Seminis Vegetable Seeds

California based Seminis Vegetable Seeds has gained control of approximately 19% of the worldwide fruit and vegetable seed market. They supply the seeds for approximately 40% of all vegetables sold in the US. The company was created through the merger of three large seed brands, Asgrow, Petoseed and Royal Sluis, as well as nine smaller companies.

Seminis is developing fungus resistant lettuce, virus resistant melon, peas with higher sugar content, and disease resistant tomatoes with higher content of beta carotene and lycopene. A collaborative agreement with Monsanto in 1997 laid the ground for applying Monsanto's technology (including Roundup Ready glyphosate resistance and Bt toxin insect resistance) to the fruit and vegetable market. This has led to the development of Roundup Ready lettuce and tomatoes.

Already being commercially marketed in the US is the virus resistant squash, originally developed by AsGrow, and approved for commercial production in 1994. A second variety, with resistance to three viruses, was approved in 1996, and a third is now being field tested. A complicating factor for the approval of GM squash varieties is the existence of wild relatives in the United States, creating the potential for virus resistance to spread to these relatives. The US Department of Agriculture accepted AsGrow's testing results for ecological safety as sufficient for approval for commercial cultivation (Source: Pesticide Action Network Updates Service 31 January 2000, via AgNet).

6.6.10 Cross-pollination

A widely reported study at the University of Maine has found that there is little cross pollination between genetically engineered and conventional corn plants in the field. Conventional corn planted 100 feet away, and downwind, of a genetically engineered corn crop, was harvested and seeds grown in greenhouses to determine cross pollination frequency. The frequency dropped from 1% to 0.03% across 18 rows of corn. The conclusion was that a buffer or border rows would effectively protect organic crops from neighbouring crops of GM plants, although organic farmers may consider any cross-pollination unacceptable (Source: Bangor Daily News 8 January 2000 via AgNet).

6.6.11 Benefits of transgenic soybeans

There have been a variety of studies concerning yields and pesticide use on transgenic soybeans which give conflicting answers as to their economic or agricultural benefits. A new report by the National Center for Food and Agricultural Policy in the US is an attempt to describe and quantify the weed control benefits provided on soybean acreage planted with transgenic soybeans in 1998. The report is available from:

<http://www.ncfap.org/pup/biotech/soy85.pdf>

6.7 **GM animal feed**

The safety and suitability of GM plant materials as animal feed is addressed through the same information for assessment of safety for human food consumption.

In the United States, the FDA is responsible for the safety of GM materials for consumption both as human food, and as animal feed.

In late 1999 the UK MAFF set up the “Advisory Committee On Animal Feedingstuffs” (ACAF), in the light of concern about the integrity of animal feeds, particularly over the implications of BSE and the use of genetically modified feed ingredients. The home page is at:

<http://www.foodstandards.gov.uk/maff/archive/food/acaf/homepage.htm>

The ACAF conducted a consultation on animal feed labelling, including GM ingredients, in early 2000. The consultation document can be found at:

<http://www.foodstandards.gov.uk/maff/archive/food/acaf/label2.htm>

This document indicates that at present, in the EU, there is no specific legislation concerning GM materials used as animal feed, and the labelling of animal feed that contains such material.

6.7.1 Background resources

The University of Guelph website includes two documents concerning the safety of GM ingredients in livestock feed.

The website is:

<http://www.plant.uoguelph.ca/riskcomm>

and the documents are:

- Beever DE, Kemp CF. Safety issues associated with the DNA in animal feed derived from genetically modified crops. A review of scientific and regulatory procedures. *Nutrition Abstracts and Review* 2000; 70: 175-182
- Livestock feed safety of GM plants and plant products. September 1999.

6.7.2 Avoidance of GM ingredients in animal feed.

Supermarkets in the United Kingdom are moving to ensure their meat, eggs and dairy products come from animals fed on foods which have not been genetically modified, as a response to consumer concerns. Tesco, the largest food retailer in the UK, has written to the international animal feed suppliers Cargill, and Archer Daniel Midlands announcing its intention to eliminate GM products from animal feed. The supermarket chain Iceland has announced that the ban on GM ingredients in feed given to poultry will take effect from February 2000. In 1998 6.5 million metric tonnes of soya was imported from the United States into Europe, the majority of which was intended for animal feed (Source: PA News 20 December 1999 via AgNet). Greenpeace claims that animal feed accounts for 80% of GM crop sales (Source: Newswire 20 December 1999 via AgNet). Marks and Spencer announced in March that they intend to remove GM soya and corn from the feed given to salmon and other farmed fish (Source: PA News 28 March 2000 via AgNet).

The large French food retailer Carrefours has assembled a group of French pork and poultry farmers and animal feed manufacturers to buy non-GM soy from Brazil, as part of an effort to remove GM organisms from Carrefour products (Source: Reuters 22 February 2000 via AgNet).

Namibia has complained to South Africa that its exports of beef to the EU are under threat because yellow maize imported as feed from South Africa cannot be guaranteed to be GM free. Up to 5% of South Africa's yellow maize crop is believed to be genetically modified (Source: Reuters 17 February 2000 via AgNet).

6.8 Miscellaneous

6.8.1 Removal of selectable marker genes

The use of antibiotic resistance genes as markers to enable the selection of cells where the insertion of new genes has been successful has been controversial. Alternatives to these genes are under development (see previous report from this project). A new report gives an alternative approach: removal of the antibiotic resistance gene following the selection process (Zubko et al, 2000). The process is based on the inclusion of two additional identical flanking sequences, which are used for intrachromosomal homologous recombination, which produces deletions, some of which delete the antibiotic resistance marker, while retaining the desired inserted sequence. The new process is claimed to be simpler and more efficient.

6.8.2 Litigation in the United States

While the safety of GM foods for human consumption in the US is the responsibility of the FDA, regulation of Bt toxins, as a pesticide, is the responsibility of the EPA. In 1997 Greenpeace and a coalition of 70 plaintiffs filed a petition the EPA charging the agency with the wanton destruction of the world's most important biological pesticide. In a victory for the plaintiffs, the EPA was ordered in February 1999 by the Federal District Court in Washington DC to respond to the plaintiffs charges within 60 days (Source: Greenpeace press release 19 January 2000 via AgNet). The EPA response was issued on 20 April and rejects the petition.

The response is available at:

<http://www.epa.gov/oppbppd1/biopesticides/news/news-greenpeace.htm>

6.8.3 Rice genome sequenced

The genome of rice has been sequenced to a "working draft" level. This is the first crop genome to be sequenced to this level of detail and will facilitate basic research to improve the crop. The research effort was undertaken by Monsanto, who will share the information with the International Rice Genome Sequencing Project (IRGSP). This is a consortium of ten laboratories and has a website at:

<http://www.staff.or.jp/Seqcollab.html>

The IRGSP had completed about one year of work in what was anticipated to be an 8 year effort. The assistance provided will enable the work to be completed within about 3 years.

6.8.4 New pesticides alternative approved by EPA

A protein that switches on a plant's natural defence mechanism has been approved by the EPA. The protein, known by the trade name Messenger, is produced from genetically engineered bacteria and has been shown to increase yields for tomatoes and peppers, and to make plants more tolerant of drought (Source: <http://www.epa.gov/pesticides>)

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