Foreword

In the period 1998 – 2003 the European Union developed enhanced assessment procedures to examine each genetically modified (GM) food, feed and crop prior to it being placed on the market. The procedures were designed to address food safety and environmental concerns, taking a precautionary, science based, case-by-case approach to regulatory approval. Notwithstanding what these comprehensive arrangements put in place, a number of Member States raised an issue, which they felt was at the heart of the debate over the production of GM crops i.e. the coexistence of GM crops with conventionally and organically produced crops.

The European Union responded to Member States concerns on coexistence by initiating a policy discussion on the subject, resulting in a 'Roundtable' examination of the issues by experts in Brussels in April 2003. Subsequently, the European Commission prepared a set of guideline principles to enable Member States to develop their own coexistence measures relevant to their particular circumstances.

In August 2003, the Department of Agriculture and Food established a Working Group to examine the issues relating to the growing of GM crops in Ireland and to develop proposals for a national strategy and best practices for the coexistence of GM crops with non-GM crops. In line with strategies being adopted by other Member States, it was considered prudent to have such a strategy in place should the Irish farming community decide to cultivate GM crops approved for planting within the EU. Coexistence guidelines/regulations are being prepared by all EU Member States, based largely on Commission Recommendation 2003/556/EC, of the 23 July 2003. This document has been most useful to the Working Group in compiling its Report.

In order to ensure that the coexistence measures recommended for Ireland were arrived at in a transparent manner and were balanced equitably between the interests of all stakeholders, the Working Group endeavoured to engage with the widest possible constituency. Submissions were invited from a broad spectrum of stakeholders including farming organisations, Teagasc, (The Agricultural & Food Development Authority) environmental groups, organic bodies, the seed trade, the animal feed industry, the biotech industry and consumers. December 31st 2004 was the last date for receipt of submissions. All submissions received were considered by the Working Group in arriving at its proposals.

In developing its recommendations the Working Group considered all the relevant issues including: overall government policy on genetically modified organisms; the principles set down in Commission Recommendation 2003/556/EC; scientific issues; current developments in GM crop technology; Irish crop production systems and farm infrastructure; and liability issues. Discussions were also held with colleagues from Northern Ireland in order to harmonise, as far as possible, coexistence measures in both jurisdictions.

It is the view of the Working Group that the recommendations contained herein, if fully implemented, would ensure the coexistence of the GM and non-GM crops discussed in this Report and minimise the risk of economic loss and the need for stakeholders to seek redress for any such loss through legal means.

Signed_____

N.P. McGill, Chairman
September 2005

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Executive Summary

Coexistence – the present position

The coexistence of GM and non-GM crops allows farmers to make a practical choice between growing conventional, organic and GM crops (those GM crops approved under Directive 2001/18/EC) while at the same time achieving the lowest practical level of adventitious admixture and complying with the legal obligations for labelling. Non-GM crops with adventitious presence of GM content above the maximum tolerance thresholds set out in the Community legislation must be labelled as containing GMOs. Admixture in excess of the tolerance threshold may have market implications and hence, financial consequences for growers. Coexistence is therefore concerned with the:

i. crop management measures to minimise admixture of GM and non-GM crops and the cost of such measures
ii. economic impact associated with the admixture of GM and non-GM crops and
iii. liability implications where there is an economic loss or where damage occurs following admixture.

The issue of coexistence was first raised by Member States in late 2002 and subsequently came to prominence in the early part of 2003 when the EU Commission initiated a policy discussion, which resulted in a 'Roundtable' examination of the issues by expert panels. The discussions sought to provide a technical and scientific basis for the measures necessary to facilitate the coexistence of the different types of crop production. Drawing on the results of the Roundtable examination and guided by the principles that farmers should be able to cultivate the types of agricultural crops they choose and the need to provide consumers with choice, the Commission, in July 2003, published a non-binding set of principles and guidelines in Recommendation 2003/556/EC, (Appendix 1). Due to the diversity of natural conditions, farm structures, farming systems, etc. between Member States, the EU Commission favoured an approach that would require each Member State to develop and implement its own management measures for coexistence i.e. subsidiarity. Focussing mainly on technical and procedural aspects, Commission Recommendation 2003/556/EC provided a list of general principles to aid Member States in establishing best practices for coexistence.

In August 2003, the Department of Agriculture and Food (DAF) appointed a Working Group to examine the issues relating to the growing of GM crops in Ireland. The remit of the Working Group was to:

(i) Identify and evaluate issues and implications for crop production in Ireland that will arise from the cultivation of GM crops.

(ii) Develop proposals for a national strategy and best practices to ensure the coexistence of genetically modified crops with conventional and organic farming.

Scientific background and methodology in preparing coexistence measures

The aim of coexistence is to ensure that the production of conventional non-GM food/feed crops that, when grown adjacent to GM crops, minimises adventitious GMO content to within the maximum threshold of the 0.9 % labelling requirement for food and feed. The baseline from which coexistence measures are determined is the adventitious presence of GMO content in seed. The EU Member States are currently debating these threshold values for seed. Threshold values of 0.3 % and 0.5 % have been proposed for cross-pollinating and self-pollinating species respectively. Pending a decision on this matter, the Working Group has taken these thresholds as the basis for the measures proposed in this Report.

While GM crops are not permitted in organic farming, the Regulation on organic farming ((EEC) No 2092/91/EC) does not stipulate a threshold value for the adventitious presence of GMOs. It is the view of the EU Commission (Commission Recommendation 2003/556/EC) that seed lots containing GM seeds below the proposed threshold values for conventional seed may be used in organic farming. The Working Group has, therefore, applied the general thresholds to organic production. If the proposed threshold values for seed are altered, or, if the regulation on organic farming stipulates significantly lower thresholds for organic production, the Working Group recommend a review of measures relating to seed and organic crops, to take account of any new standards.

The agricultural crops at the more advanced stage of development for future GM commercial production in the short to medium term in Ireland include maize, beet, potato, cereals, oilseed rape, and possibly some horticultural crops. The nature and extent of measures required for coexistence varies greatly for the different types of crops and will depend on many factors including; whether the crop produces pollen in its normal production cycle; is self- or cross-pollinating; has an annual or biennial flowering cycle; has related wild relatives; produces volunteers; survives in the seed bank; survives over winter; etc.

The routes whereby admixture may occur in these crops were examined and include:

(i) The presence of GM seed in non-GM seed.
(ii) GM plants establishing from the seed bank i.e. volunteers.
(iii) Cross-pollination from nearby GM crops, volunteers or wild relatives.
(iv) Transfer of seed through physical or mechanical means i.e. sowing and harvesting operations and transport equipment and storage.
(v) Survival in straw and organic waste.

The factors considered by the Working Group in the determination of the extent of gene dispersal in an Irish context included:

(i) Crop specific gene-dispersal potential.
(ii) Distribution and relative concentrations of conventional and organic cropping.

(iii) Farm size, fragmentation and extent of land rental/leasing.
(iv) Extent of future GM cropping.

Crop management for coexistence is based on a number of key measures namely:

(i) Use of pure seed.
(ii) Crop separation.
(iii) Control of weeds and volunteers facilitated by appropriate rotation intervals.
(iv) Prevention of seed movement during sowing, harvesting, transport and storage operations.

Additional tools for maintaining crop purity include:

(i) The use of buffer zones to absorb GM derived pollen.

(ii) Regional measures i.e. zones of a single production type. The legislative position regarding zones of a single production type, or specifically GM-free zones, stipulate that GM-free zones can only be established where there is a scientific justification for an individual crop or crop type where GM and non-GM cannot coexist in a particular region. However, GM-free zones may be established by way of voluntary agreement between all farmers in a particular region whereby the growing of various crop types are segregated through the coordination of production practices.

(iii) Genetic out-crossing barriers have possibilities for the future, although these are limited in their application at present.

The crop management measures recommended by the Working Group for coexistence are science-based and take into consideration the characteristics of the crop and the farming system in Ireland. The recommendations were derived primarily through consultation of scientific publications specific to individual crops and from the existing knowledge base derived from the multiplication of seed from individual crops in the operation of the Irish Seed Certification Scheme. However, while providing guidance and direction to the Working Group, the technical management requirements for seed multiplication are not, in themselves, an appropriate blueprint for the coexistence of GM and non-GM crops due to divergence in objectives and technical requirements. In addition, measures for the certification of seed are insufficient to address some of the key issues associated with the coexistence of GM crops and non GM crops, i.e. economic loss and liability.

The coexistence arrangements in place, both in the EU and elsewhere, were examined to determine their relevance or possible application to Irish farming conditions. Hence, measures are demonstrated by reference to international best practice.

The Working Group collaborated with the Northern Ireland Authorities on the harmonisation of coexistence measures and in particular where farm boundaries do not

coincide with national borders. Discussions are ongoing between both parties in this regard.

Analysis of crops and management measures

In the event of GM crops being grown in Ireland, it is likely that they will be grown in **regions** where existing conventional counterparts are prominent. Much of the tillage production in Ireland is located in the eastern and southern regions. While cereal production is generalised throughout these regions, other crops such as potatoes and horticultural crops are relatively concentrated in specific counties.

With adherence to recommended measures for crop management, it is the view of the Working Group that the coexistence of GM and non-GM **maize**, **beet**, **potato** and **cereals** can be successfully achieved within current Irish production systems. The degree of additional management input will vary significantly depending on the crop.

The coexistence of GM and non-GM **oilseed rape** is more problematic. With the wide divergence of research data in the scientific literature with respect to pollen flow and the propensity for volunteer plants to survive over longer periods of time under Irish climatic conditions, crop separation distances for oilseed rape have not been set down until such time as further data (preferably of Irish origin) becomes available. Coexistence of oilseed rape is further complicated due to the existence of a number of cultivated and wild relatives.

Taking account of the extensive range of **horticultural crops** produced in Ireland, and given that there is unlikely to be any production of GM horticultural crops in the short-term, the Working Group does not recommend any measures for the coexistence of GM and non-GM horticultural crops. Measures should be developed for horticultural crops on a case-by-case basis if and when the necessity arises.

The use of **pure seed** is essential for the maintenance of purity in all crops. For non-GM crops it is an essential pre-requisite for minimising admixture. Use of certified seed and the testing of home-saved seed for GMO content will provide an assurance of seed purity.

Adherence to procedures for the prevention of seed admixture during **mechanical operations** involving sowing, harvesting, on-farm transport, on-farm storage, transport off-farm and at merchant's premises will be essential for coexistence. Some crops, especially oilseed rape, will present more of a challenge in this respect.

With the fragmented nature of Irish tillage farms and a high degree of short-term land rental, a very high level of **communication between neighbouring farmers** will be necessary over time to ensure the measures are implemented and adhered to. In some cases, a GM crop grower will not be in a position to grow a GM crop independently of his neighbour while at the same time observing the appropriate separation distance.

In the short-term, where the initial uptake of GM crops is likely to be low, it is envisaged that requirements for adjustment in current farming practices (e.g. crop rotations) will be limited in order to comply with **separation distances**. In the event of more widespread cultivation of GM cereals, beet and potatoes, significant changes in cultivation practices to meet separation distances are not anticipated, as the separation requirements for these crops are low. However, widespread cultivation, or high concentrations in specific areas, of GM maize and oilseed rape will require a significant management input to achieve coexistence.

In sites where a non-GM crop is grown after a GM crop, adherence to recommended **rotation intervals** and control measures will be essential to control GM-derived volunteer plants and weeds.

In view of the fact that the market for **organic produce** may specify somewhat lower thresholds for adventitious admixture of GMO content than that of 0.9 % for food and feed, and taking account of the relatively small-scale farm size structure of organic units, the recommended separation distances between GM crops and organic crops are 50% greater than those recommended for conventional crops. It is recommended that this be increased to 100% for organic seed crops.

Given the present level of organic crop production in Ireland, a limited introduction of GM crops should not pose a significant risk to organic crop production in the short-term. In addition, the range of GM crops currently available for commercialisation (oilseed rape and maize) are not grown to any significant extent by the organic sector in Ireland.

Coexistence implications for organic farming arising from the introduction of GM crops in the longer-term will depend on:

(i) The degree of expansion in organic farming units and the overall production area.
(ii) The extent of production and number of growers of GM cereals, potatoes and other horticultural crops.
(iii) A change in current organic production practices where organic production of oilseed rape, beet and maize may develop and where there is also cultivation of GM varieties of these species.

Where GM crop species are grown in proximity to their organic equivalents, in addition to extended separation distances, similar farm management measures as those outlined for coexistence with conventional crop production, will be necessary.

A national strategy for the implementation of coexistence

The implementation of crop management measures is central for coexistence. The Working Group considered that the strategy for the implementation of coexistence should have a number of key objectives, namely:

- Be in keeping with the overall positive but precautionary policy expressed by the Government in relation to GMOs.

- Protect the integrity of non-GM crops and be sufficiently robust to underpin Ireland's clean green agricultural production image.

- Meet the obligations placed on Member States by EU Directive 2001/18/EC on the deliberate release of GMOs into the environment and Commission Regulation 1829/2003 and 1830/2003 on the labelling and traceability of food and feed.

- Take account of the guidelines issued in Commission Recommendation 2003/556/EC of 23 July 2003 in order to achieve a degree of harmony with measures proposed by other EU Member States. The measures should be practical, cost-effective, proportionate and should ensure an equitable balance between the interests of all production types. They should meet requirements regarding land registers, education and training, record keeping and post-release monitoring. Implementation of the measures should not be unduly onerous and thus prove a deterrent to the managed development of GM crops in Ireland.

- Inspire confidence in all stakeholders. The Working Group endeavoured to engage with the widest possible constituency by inviting submissions from a broad spectrum of stakeholders including farming organisations, Teagasc, environmental groups, organic bodies, the seed trade, the animal feed industry, the biotech industry and consumers. The Working Group took all submissions received into consideration in the preparation of its Report.

While no specific implementation policy for coexistence is recommended by the EU Commission, the Working Group examined a number of options including:

(i) a voluntary code of practice
(ii) a system based entirely on mandatory measures and,
(iii) a combined voluntary and mandatory arrangement.

It is the view of the Working Group that a combined mandatory and voluntary arrangement best meets the above objectives. The Working Group recommend that certain elements of coexistence be mandatory, while others, associated principally with crop management measures, be incorporated into a Code of Good Farming Practice. Such an approach necessitates underpinning with procedural arrangements and the provision and exchange of information.

Mandatory measures for coexistence require that they be given legal status. A Statutory Instrument, based on Article 26a of the EU Directive 2001/18/EC on the deliberate release into the environment of genetically modified organisms, should be put in place as an interim measure until an Act of the Oireachtas is created to give the measures for the cultivation of GM crops its own stand-alone legislation. Measures based on a Statutory

Instrument could be implemented without delay but would be less amenable to amendment on an ongoing basis. An Act of the Oireachtas however, which could take longer to enact initially, would more readily facilitate any changes requiring to be made over time.

Mandatory measures for cultivating a GM crop include:

1. Approval by the DAF before cultivation can commence, subject to the provision of all information requested.

2. Confirmation that the GM crop grower has undertaken the required education and training on the cultivation of GM crops.

3. Demonstration that agreement has been reached with neighbouring farmers in respect of cropping arrangements that involve all/part of the neighbours land being used to establish the required crop separation distance.

4. Maintenance of comprehensive records in relation to all aspects of the production of the crop.

5. Sanctions being imposed for breaches of mandatory measures.

Code of Good Farming Practice includes:

1. Adherence to recommended rotation interval and control of volunteers and weeds.

2. Correct use of machinery and equipment and the secure transport and storage of GM produce.

3. Home-saved seed used for the production of a non-GM crop should be tested to confirm seed purity.

4. Notification to contiguous neighbours where there is intention to cultivate a GM crop.

The implementation of coexistence will depend on the DAF providing a number of key functions including:

1. A framework for compliance inspections and for addressing non-compliance to make adherence to the measures an accountable process.

2. Provision of a reliable, efficient and cost-effective sample analysis service.

3. Establishment of a database by the DAF will be necessary for the management of coexistence. Certain information from this database i.e. GM crop species and their location (through the Land Parcel Identification System (LPIS)), should be accessible to the public via a dedicated website.

4. Ongoing monitoring and evaluation to verify the effectiveness of coexistence measures and to improve them over time. Monitoring is facilitated through the compliance inspection programme and additional targeted crop sampling and analysis. Monitoring should be comprehensive during the initial years of GM crop cultivation and should be carried out by, or under the supervision of, the DAF. Among the factors to be considered when setting out a protocol for monitoring is the possible linkage of coexistence monitoring with environmental post-release monitoring under Directive 2001/18/EC. Some of the parameters are common to both e.g. gene flow. Such linkage would serve to strengthen the validation of measures and reduce cost.

5. Periodic review of coexistence measures. Measures should be continuously updated, initially after two years and as required thereafter. Amendments should be made where necessary depending on the result of monitoring activity, the availability of more up-to-date relevant scientific information and developments at EU level and in other Member States.

Economic loss and redress

Where coexistence measures are implemented satisfactorily, it is expected that the extent of economic loss as a result of admixture of non-GM crops with GM crops will not be significant.

Where a non-GM crop grower incurs a verifiable and quantifiable economic loss as a result of the maximum labelling threshold in his/her crop being exceeded through admixture by the actions of a third party, it is the view of the Working Group that the affected grower should be compensated.

The Working Group examined possible methods for the redress of economic loss including:

Insurance – to date, the insurance industry has not indicated a willingness to offer insurance for economic loss with respect to the GM sector.

Private settlements – as part of the training and education modules undertaken by growers in preparation for the growing of GM crops, growers will be encouraged to make every effort to agree private settlements where the liable party can be identified.

Redress fund – in order to simplify and expedite redress for affected growers, the Working Group recommend that a fund should be established for the redress of economic

loss, should the necessity arise. Such a fund should be established initially by the State, but on a cost recovery basis. The recovery of costs should be from contributions from the main beneficiaries i.e. the GM crop grower, biotech companies and other industry beneficiaries.

An **Independent Body** should be established to adjudicate on the nature and extent of the economic loss and to carry out the administration of the fund. The conditions of payment from the fund should be clearly defined and strictly controlled.

Civil law – Notwithstanding the establishment of a redress fund, or where private settlements have not been agreed, National law on civil liability would still apply and non-GM crop growers are entitled to pursue a civil action through the Courts.

Future research

Several areas necessitating further investigation are highlighted in the Report.

(i) Economic evaluation:

- Holistic analysis of the economic consequences of GM crop cultivation in Ireland.

- Examination of the balance between the potential benefits associated with GM crop cultivation and the cost of adhering to coexistence measures.

(ii) Improving knowledge on how best to ensure coexistence:

- Examining the extent of pollen dispersal from crops, especially oilseed rape and the potential for cross-pollination with cultivated and wild relatives and volunteers with a view to the establishment of the most appropriate management measures for the coexistence of GM and non-GM crops under Irish conditions.

- The precise effect of buffer zones under Irish conditions.

(iii) GM Crops and Biodiversity:

- Monitoring the impact of GM crops on biodiversity.

- Investigation of management regimes that impact positively on biodiversity.

Research should be commissioned to enable referral to credible and soundly based independent scientific data on these matters from an Irish context.

Key Recommendations

1. **A combined mandatory and voluntary arrangement best meets the objective of implementing coexistence measures. Mandatory measures require that they be given legal status, while voluntary measures should be specified in a Code of Good Farming Practice.**

2. **Growers must obtain prior approval from the DAF to grow GM crops and applications should be lodged a minimum of 60 days prior to the planned date of sowing.**

3. **Growers of GM crops must attend prescribed education and training courses. All other interested parties, e.g. neighbouring non-GM crop growers, seed suppliers, machinery and transport operators, contractors, advisers/extension workers etc., should attend education and training courses on GM crop production and coexistence.**

4. **The crop separation distances between GM crops and non-GM crops as set down in this Report must be observed.**

5. **A GM crop grower must obtain signed written agreement with his/her neighbour, where part of the neighbour's farm is required to satisfy the necessary separation distance. This agreement must be submitted as part of the application for approval to grow a GM crop.**

6. **Growers must keep records on all aspects of the GM crop grown for a minimum period of five years. Such records must be made available for inspection to the relevant authority.**

7. **Non-adherence to mandatory coexistence measures should incur sanctions.**

8. **A mechanism should be established to allow for appeals on decisions taken by the DAF with respect to approvals for GM crop cultivation and sanctions imposed.**

9. **All those intending to grow GM crops should be encouraged to consult with their contiguous farming neighbours and to give them written notification of their intention prior to sowing of the GM crop.**

10. **Growers should observe the required crop rotation intervals and control volunteer plants, bolters and related weed species in order to reduce the risk of admixture to non-GM crops.**

11. **GM crop growers, contractors and all operatives involved in the production of GM crops should adhere to a Code of Good Farming Practice with respect to the cleaning of farm machinery and equipment, and the secure transport and storage of GM produce.**

12. **A register of those approved to grow GM crops, showing the GM crop species, area and the location (using the Land Parcel Identification System - LPIS), should be accessible to the public through a dedicated website.**

13. **Crop management and procedural measures should be subject to compliance inspection. This should be carried out by, or under the supervision of, the DAF.**

14. **Where a non-GM crop grower incurs a verifiable and quantifiable economic loss as a result of the maximum labelling threshold in his/her crop being exceeded through admixture by the actions of a third party, the affected grower should be compensated.**

15. **Where the party liable for admixture can be identified, every effort should be made by the affected parties to reach a private settlement.**

16. **A fund should be established for the redress of economic loss if and when the necessity arises. Such a fund should be established initially by the State, but on a cost recovery basis. The recovery of costs should be from contributions from the main beneficiaries i.e. the GM crop grower, biotech companies and other industry beneficiaries. (Notwithstanding the establishment of a redress fund, National law on liability would still apply and non-GM crop growers are entitled to pursue a civil action through the Courts).**

17. **An Independent Body should be established to adjudicate on the nature and extent of the economic loss and to carry out the administration of the fund. The conditions of payment from the fund should be clearly defined and strictly controlled.**

18. **The coexistence measures recommended in this Report should be subject to on-going monitoring and evaluation by the DAF, or under its supervision, to verify their effectiveness. The measures should be reviewed initially after 2 years and as deemed appropriate thereafter.**

19. **A database should be established by the DAF with respect to all applicants to grow GM crops, wherein, all necessary details of the applicant, the crop and the management of the crop should be recorded for analysis and coexistence management purposes.**

20. **Research should be commissioned in relation to the: (i) economic impact for Ireland from GM crop cultivation; (ii) costs of coexistence measures; (iii) coexistence of GM and non-GM oilseed rape; and (iv) impact of GM crop management regimes on biodiversity.**

21. **Where independent scientific analysis suggests that a GM crop could not coexist with its non-GM equivalent, within the thresholds pertaining under normal coexistence management measures, the State should consider an application to the EU Commission to establish a GM free zone on such a specific crop at regional level.**

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Glossary of Terms and Abbreviations

AAU:
Agricultural Area Used (as applies to farm size).

Adventitious presence:
Refers to the unintentional or accidental occurrence of one type of material in another.

Agrobacterium tumefaciens:
A bacterium that causes crown gall disease in some plants. The bacterium characteristically infects a wound and incorporates a segment of Ti plasmid DNA into the host genome. This DNA causes the host cell to grow into a tumour-like structure that synthesises specific carbon sources that only the pathogen can metabolise. This DNA-transfer mechanism is exploited in the genetic engineering of plants.

Allergy:
A hypersensitivity to a substance that causes the body to develop an immune response.

Allergen:
Any substance capable of inducing an allergy.

Amino acid:
A compound containing both amino (NH_2) and carboxyl (-COOH) groups. In particular any of 20 basic building blocks of proteins.

Anther:
The upper part of a stamen, containing pollen sacs within which the pollen develops and matures.

Anthesis:
The period during which the anthers bear mature and functional pollen.

Antibiotic:
A class of natural and synthetic compounds that inhibit the growth of, or kill some micro-organisms.

Antibiotic resistance:
The ability of a micro-organism to disable an antibiotic or prevent its transport into the cell.

Antibiotic resistance marker gene:

Genes, usually of bacterial origin, used as selection markers in transgenesis, because their presence allows cell survival in the presence of normally toxic antibiotic agents. These genes were commonly used in the development and release of first generation transgenic organisms (particularly crop plants).

Antigen:

A substance that elicits an immune response and stimulates the production of antibodies.

Arabidopsis:

A genus of flowering plants in the *Cruciferae*. *A. thaliana* is used in research as model plant because it has a small fully sequenced genome, can be cultured and transformed easily, and has a rapid generation time.

Asexual:

Reproduction not involving meiosis or the union of gametes.

Bacillus thuringiensis (Bt):

A bacterium that produces a toxin against certain insects, particularly *Coleoptera* and *Lepidoptera*.

Biennial:

A plant that completes its lifecycle in two years, flowering in the second year, and then dies.

Biodiversity:

The variability among living organisms from all sources, including, *inter alia*, terrestrial, marine and other ecosystems and the ecological complexes of which they are part.

Biofuel:

A gaseous, liquid or solid fuel derived from a biological source, e.g. ethanol, rapeseed oil or fish liver oil.

Biopharming:

The use of genetically transformed crop plants and livestock animals to produce valuable compounds, especially pharmaceuticals.

Bioremediation:

A process that uses living organisms to remove contaminants, pollutants or unwanted substances from soil or water.

Biotechnology:

"Any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use" (Definition from the Convention on Biological Diversity).

Bolter:

Premature flowering e.g. of a beet plant in year one of its two year biennial cycle.

Bt:

See *Bacillus thuringiensis*.

CA:

Competent Authority.

Canola:

A specific group of oilseed rape cultivars.

Cell:

The smallest structural unit of living organisms that is able to function independently.

Certified seed:

Officially approved commercial seed that is distinct from other varieties, is uniform and stable, remains true to type over time and is sufficiently pure and free of pests and diseases for agricultural use.

Chloroplast:

Specialised segment of the cell containing chlorophyll and involved in the synthesis of sugars and starch. Chloroplasts have their own DNA; these genes are inherited only through the female parent and are independent of nuclear genes.

Chromosome:

In eukaryotic cells, chromosomes are the nuclear bodies containing most of the genes largely responsible for the differentiation and activity of the cell. They contain most of the cell's DNA and each eukaryotic species has a characteristic number of chromosomes.

Clone stock:

Group of plants genetically identical in which all are derived from one selected individual by vegetative propagation.

Codon:

One of the groups of three consecutive nucleotides in mRNA, which represent the unit of genetic coding by specifying a particular amino acid during the synthesis of polypeptides in a cell.

Convention on Biological Diversity (CDB):

The international treaty governing the conservation and use of biological resources around the world, that has also called for the establishment of rules to govern the international movement of non-indigenous living organisms and genetically modified organisms.

Conventional agriculture:

Traditional agricultural practices excluding GM and organic production methods.

Cross-fertilisation:

The union of male and female gametes from different individuals of the same species.

Cross-pollination:

Application of pollen from one plant to another to effect the latter's fertilisation.

CSO:

Central Statistics Office.

Cultivar:

An internationally accepted term denoting a variety of a cultivated plant. Must be distinguishable from other varieties by stated characteristics and must retain their distinguishing characters when reproduced under specific conditions.

DAF:

Department of Agriculture and Food.

DAFRD:

Department of Agriculture, Food and Rural Development.

DEHLG:

Department of Environment, Heritage and Local Government.

DELG:

Department of the Environment and Local Government.

Deliberate release:

In the context of biotechnology, the intentional release under approved legislation, of GMOs either for experimental or commercial use.

DETE:

Department of Enterprise, Trade and Employment.

DHC:

Department of Health and Children.

Deoxyribonucleic acid (DNA):

A long chain polymer of deoxyribonucleotides. DNA constitutes the genetic material of most known organisms and organelles, and usually is in the form of a double helix, although some viral genomes consist of a single strand of DNA and others of a single- or double-stranded RNA.

Diploid:

The status of having two complete sets of chromosomes, most commonly one set of paternal origin and the other of maternal origin.

DUS:

Distinctiveness, **U**niformity and **S**tability tests as used for variety identification in official crop variety registration.

EC:

European Community.

ECB:

European Corn Borer.

EU:

European Union.

EP:

European Parliament.

EPA:

Environmental Protection Agency.

Feral population:

A population (plant or animal) developing in a wild and uncultivated state.

Fungicide:

A chemical agent toxic to fungi.

FSAI:

Food Safety Authority of Ireland.

Gene:

The unit of heredity transmitted from generation to generation during sexual or asexual reproduction. More generally, the term is used in relation to the transmission and inheritance of particular identifiable traits. The simplest gene consists a segment of nucleic acid that encodes an individual protein or RNA.

Gene bank:

The location where collections of genetic material in the form of seeds, tissues, or reproductive cells of plants or animals are stored.

Gene flow:

The spread of genes from one breeding population to another (usually related) population by migration.

Gene stacking:

Where two or more modified genes are included in the genome of an organism.

Genetic engineering:

The process of modifying an organism's genotype.

Genetic marker:

A DNA sequence used to identify a specific location on a particular chromosome.

Genetic modification (GM):

The technology of altering genetic material of an organism by the direct introduction or removal of deoxyribonucleic acid (DNA).

Genetic use restriction technology (GURT):

A proposed technology applying transgenesis to genetically compromise the fertility or performance of saved seed of a cultivar or of second generation animals. The intention is to protect the market for the seed producer or to prevent undesired escape of genes.

Genetically modified organism (GMO):

An organism in which the genetic material has been altered by the direct introduction (or removal) of DNA.

GM construct:

The engineered unit transferred into the host plant, typically containing the gene or genes of interest, a marker gene and appropriate control sequences as a single package.

GM crops:

One type of GMO. Crop plants whose genetic material has been altered by the direct introduction or removal of DNA in order to confer particular characteristics on the plant.

GM feed:

Animal feed harvested from a GM crop.

GM food:

Food that contains above a certain legal minimum content of raw material obtained from genetically modified organisms.

GM grain:

Grain harvested from a GM crop and intended for use as animal feed.

GM non-food crops:

A subset of GM crops that are not used in food or feed. GM crops for industrial/medicinal use.

GMO:

Genetically modified organism.

GM seed:

Seed harvested from a genetically modified crop and intended for planting another GM crop.

Genome:

The entire complement of genetic material (genes plus non-coding sequences) present in each cell of an organism, virus or organelle.

Genomics:

Research into the structure, function and evolution of genes.

Glucosinolates:

A class of molecules produced in the seeds and green tissue of a range of plants, in particular brassicas. Their natural role is thought to be involved in plant-insect interactions. Their importance in plant breeding is largely because of their negative influence on taste and their positive effect on the prevention of cancers of the alimentary tract.

Green revolution:

Name given to the dramatic increase in crop productivity during the third quarter of the 20^{th} century, as a result of integrated advances in genetics and plant breeding, agronomy, pest and disease control, etc.

Haploid:

A cell or organism containing one of each of the pairs of homologous chromosomes found in the normal diploid cell.

Herbaceous:

A non-woody plant.

Herbicide:

A substance that is toxic to plants. The active ingredient in agrochemicals intended to kill specific unwanted plants, especially weeds.

Hybrid seed:

In plant breeding, used colloquially for seed produced by specific crosses of selected pure lines, such that the F_1 crop is genetically uniform and displays hybrid vigour. As the F_1 plants are heterozygous with respect to many genes, the crop does not breed true and so new seed must be purchased each season.

Hypoallergenic:

A substance not likely to cause an allergenic reaction.

ICSTI:

Irish Council for Science, Technology and Innovation.

Insecticide:

A substance that kills insects.

Insulin:

A peptide hormone secreted by the Langerhans islets of the pancreas and that regulates the level of sugar in the blood.

Introgression:

Spread of genes of one species into the gene pool of another by hybridisation and backcrossing.

Lepidopteran:

Any of a large order of insects typically having two pairs of wings covered with fragile scales. Comprises butterflies and moths.

Marker gene:

A gene of known function or known location, used for marking marker-assisted selection or genetic studies.

MCB:

Mediterranean Corn Borer.

Meristem:

The plant tissue responsible for growth, whose cells divide and differentiate to form the tissues and organs of the plant.

mRNA:

Messenger RNA

Notifier:

The company submitting an application for approval of a GM product to the EU for evaluation under Directive 2001/18/EC.

Open pollination:

Pollination by wind, insects or other natural mechanisms.

Organelle:

A membrane-bound specialised region within a cell that carries out a specialised function within the cell.

Panicle:

An inflorescence, the main axis of which is branched; the branches bear loose racemose flower clusters. Rice and oats are crop plants with a panicle inflorescence.

Phenotype:

The visible appearance of an individual (with respect to one or more traits) which reflects the reaction of a given genotype with a given environment.

Plasmid:

A small circle of bacterial DNA that is independent of the main bacteria chromosome. Plasmids often contain genes for drug resistances and can be transmitted between bacteria of the same and different species.

Precautionary principle:

The approach whereby any possible risk associated with the introduction of a new technology is avoided, until a full understanding of its impact on health, environment, etc., is available. Particularly applied to the release of genetically modified organisms, since unlike many technologies, these cannot be recalled if problems arise.

Promoters:

Promoters are sequences of DNA that 'switch on' genes to carry out particular functions in different parts of the plant (and at particular points in its lifecycle).

Recombinant DNA (rDNA):

The result of combining DNA fragments from different sources.

Rennet:

A substance used for curdling milk in making cheese.

Self-pollination:

Transfer of pollen from the anthers to the stigma of the same flower or to another flower of the same plant.

Separation distance:

The distance between the perimeter of a GM crop and the perimeter of another crop which is sexually compatible with the GM crop.

S. I.:

Statutory Instrument.

Silk:

The female inflorescence of the maize plant.

Species:

A taxon ranking in the hierarchy of biological classification as the category below genus. The species is the basic unit of biological classification. Plants within the species limit, will normally pollinate, fertilise and set seed naturally, unless selected for a form of sterility.

Stacked genes:

Refers to the insertion of two or more genes into the genome of an organism.

Stamen:

Floral structure made up of an anther and a filament. The stamen is the male organ of a flower.

Sterile:

Permanently unable to reproduce.

Tagging:

A process of attaching a compound (label) to a molecule in order to allow detection of its presence following transfer.

Tassel:

The male inflorescence of the maize plant.

Teagasc:

The Agriculture and Food Development Authority.

Terminator gene:

A gene that renders the seed from that plant sterile.

TPS:

True potato seed.

Transgenesis:

The introduction of a gene or genes into animal or plant cells, which leads to the transmission of the input gene (transgene) to successive generations.

Triticale:

The hybrid man-made species formed by the crossing of tetraploid or hexaploid wheat with diploid rye.

VCU:

Value for **C**ultivation and **U**se test used in official crop variety registration.

Vernalisation:

A period of cold treatment for plants to trigger the initiation of flower formation.

Volunteer plant:

A crop plant growing from seed or vegetative material from a previous crop.

WCR:

Western Corn Rootworm.