

Genetically modified organisms

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Breeding agricultural plants

Plant breeders have traditionally crossed plants that exhibit wanted properties and selected among the offspring those that had acquired the wanted properties, but this can only be done when the cross produces fertile offspring. With recombinant DNA technology, it is possible to cut a small piece of DNA from one species (donor), introduce it into the DNA of another species (host) with which it cannot cross, but in which the donor DNA is expressed. The host species, now called a genetically modified organism (GMO), thus acquires a new property it could not have obtained by conventional breeding (*Nature* 2002).

The first GMO was constructed in 1972; 10 years later a genetically modified plant was produced and by 1996, 2.8 million hectares of commercial crops were grown. By 2004, 8 million farmers in 17 countries grew 81 million hectares of modified soya bean, cotton, canola and maize (James 2004). Genes that confer herbicide resistance and insect tolerance are the most widely used genes commercially (Akhurst et al 2002 and Maclean et al 1997).

Surveillance of the technology

The Australian government assumed responsibility for the regulation of gene technology in 1981 and established a non-statutory authority, the Recombinant DNA Monitoring Committee (RDMC), later replaced by the Genetic Manipulation Advisory Committee (GMAC). In 2000, with the passing of the *Gene Technology Act 2000*, the Office of the Gene Technology Regulator (OGTR) was established, with responsibility for regulating research, field trials and commercial production of genetically modified organisms (Senate Community Affairs References Committee 2000).

Prior to any dealing with a genetically modified organism, a licence must be obtained from the OGTR. Applicants for a licence must provide detailed information about the host, the donor, the transferred DNA, how the DNA is transferred, the properties of the resulting

GMO, especially its fitness and fertility and where the GMO will be grown. The OGTR then conducts a formal risk assessment, in consultation with relevant state, territory and Australian government agencies and the general public. Following this process, the OGTR makes a decision on whether to grant a licence.

The *Gene Technology Act* also provides for the designation of areas by a state for the purpose of preserving the identity of genetically modified or non- genetically modified crops for marketing purposes. Such designation can have the effect of imposing a moratorium on the commercial cultivation of genetically modified crops, even when a licence has been granted by OGTR.

Victoria, New South Wales, South Australia, Western Australia, Tasmania and the Australian Capital Territory have each passed special moratorium legislation to control commercial production of genetically modified crops. Western Australia has a moratorium on the cultivation of all genetically modified (GM) crops until December 2008. South Australia has a moratorium on all GM food crops and has extended its moratorium on canola from 2006 to 2008. Victoria has a moratorium on cultivation of GM canola until 2007 but allows GM carnations. New South Wales has a moratorium on the commercial cultivation of all GM food crops until March 2008. Tasmania has a moratorium on the commercial cultivation of GM crops until November 2009, initially via quarantine legislation, and now through special moratorium legislation. The Australian Capital Territory has a moratorium on the cultivation of GM canola and other GM food crops until June 2006. Under these arrangements, however, the states and territories allow the conduct of OGTR approved experimental trials of GM crops.

Genetically modified cotton (herbicide resistant and insect tolerant) and genetically modified carnations (colour modified) are the only commercial GM plants grown in Australia at this time (Bt cotton 80,000 ha; carnations <10ha) (see note for description of Bt cotton). A wide variety of broad acre crop and horticultural plants have been grown in small field trials in all states of Australia.

Concerns with genetically modified organisms

The risk assessment and management process carried out under the legislation looks at a range of issues that may present risks to human health or the environment. After scientific evaluation a judgement is made as to whether the risk can be eliminated, minimised or managed to an acceptable level.

Examples of these issues include potential for:

- pollen from the GMO may carry to a non-GMO crop, thus introducing the novel gene into a conventional crop (Rieger et al 1999),
- pollen from a herbicide resistant GMO may cross with a compatible weed and introduce resistance in the weed (Rieger et al 1999),

- herbicide resistant crop plants may emerge in a following season and be difficult to control,
- insects might develop resistance to insecticides made in GMO plants (e.g. Bt cotton),
- harm might result to soil biota, thus harming nutrient cycling,
- the GMO might have a poor nutritional profile or be poorly digested and
- the GMO might make a toxin, allergen or teratogen.

Data on these potential hazards, the probability of them occurring and the ability to control them, are required by the Office of the Gene Technology Regulator (OGTR) prior to a risk analysis for genetically modified plants grown in contained glasshouses and in small field trials, before larger-scale trials and commercial production would be permitted. Before open trials begin, the GMOs can be analysed and tested for the presence of harmful components, lack of essential nutrients, digestibility and pollen travel.

The risk of pollen spread and outcrossing to weeds varies considerably. Some plants are self pollinating and low risk, whereas others outcross routinely within species and close relatives, and sparingly with distantly related weeds (e.g. canola). Trees such as eucalypts hybridise readily over long distances (e.g. kilometres) and flower, as a forest, over many months (Ashton 2003). Outcrossing here could be controlled by ensuring that the pollen of the GMO is sterile.

With outcrossing genetically modified organisms, the OGTR can set buffer zones free of the GMO to control the spread of pollen.

There has also been concern in the community about genetically modified organisms from the point of view of the religious or moral implications of such technology, or a preference for a particular life style or food ('organic food'), or concern about market power that may result from particular seed product licensing arrangements. These factors are not taken into consideration under the current regulatory process, which focuses on risks to human health and the environment.

Benefits from genetically GMO crops

GMO crops can confer social and environmental benefits:

- herbicide resistant crops need less tillage, which enhances the content of organic matter in the soil, reduces erosion by wind and water and improves soil structure. Less herbicide is used resulting in less runoff to watercourses.
- plants producing toxins selective against caterpillar larvae reduce the number of sprays of persistent chemicals by up to 60%. This spares useful insects and reduces the pollution of soil and waterways with chemicals.
- GMO crops can be made that produce vitamins lacking in some staple crops e.g. genes for vitamin A production introduced into rice (MacLean et al 1997).

- research is in progress to increase salt or drought tolerance – an important consideration as the world population rises and, currently, arable land is at a premium.

Gene technology exploits our knowledge of the universal nature of the genetic code; it enables plant breeders to develop useful cultivars that are unattainable by conventional practices. Some sectors hold concerns as to the safety of genetically modified organisms, but with careful, scientific scrutiny, the management of putative risks becomes possible.

Note:

Bt or Ingard cottons have been grown commercially in Australia since 1996. They produce an insecticidal protein from the naturally-occurring bacterium, *Bacillus thuringiensis*, and were developed to help in the control of the main insect pests of cotton — *Helicoverpa armigera* and *H. punctigera*.

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