1E: GENETICALLY MODIFIED ORGANISMS (GMOS) – GUIDING MEANINGFUL OPINIONS

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What is gene technology?

Scientists, breeders and farmers have been improving existing plant varieties and animals for thousands of years. Gene technology is the latest addition to these breeding techniques.

Genes are tiny units of a chemical called deoxyribonucleic acid (DNA) which form part of each chromosome. Genes provide hereditary information which determines a particular characteristic of an organism. Because the chemical language of DNA is the same in all living things, it is possible to transfer a gene, and the physical characteristics it controls, from one organism to another, without altering other characteristics of the recipient organism. For example, a gene could be moved from bacteria to a plant, or from non-crop to crop plants – a task previously impossible using traditional breeding techniques.

Gene technology is also known as 'genetic engineering' (GE) or 'genetic modification' (GM). A product which has been genetically modified is often referred to as 'transgenic'.

Around the world

The first commercial applications of gene technology in crop plants have involved modifying the plant for greater disease- or insect- resistance or for a more efficient production system. Introduction of these GM crops has been very rapid, particularly in the United States.

In 2000, 44.2 million hectares were sown to GM crops, with global sales totalling $2.5 billion. The USA accounted for 68 per cent of the total global area, with Australia growing less than one per cent. In terms of crops, soybean accounted for 58 per cent of the total global area, with corn/maize equalling 23 per cent, cotton 12 per cent and canola/rapeseed accounting for seven per cent. [1]

There are currently two GM commodities grown in Australia – carnations and cotton. More than 10 billion carnations are produced around the world each year, with the Australian carnation industry producing approximately 60 million flowers across South Australia, Western Australia, New South Wales and Victoria. The world's first GM carnation, 'Moondust', has been commercially available in Australia since October 1996. It contains genes from petunia and snapdragon flowers, which allow it to express blue colouring. It has been followed by four other carnation varieties utilising the 'blue' technology.

In the cotton industry, Ingard/Bt cotton was the first commercial variety released. To develop the cotton, scientists added a gene to the plant from a bacterium commonly found in soil, *Bacillus thuringiensis* (Bt). The resulting insect resistant cotton plants produce a natural protein in their leaves which kills cotton's worst pest, heliothis. Since its introduction in 1996, Ingard cotton has reduced pesticide use by 50 per cent of the insecticides used on a conventional crop – a reduction of 1.5 million litres of spray per year.[2] This has been well received by the cotton industry and surrounding regional centres, with cotton growers embracing the environmental benefits.

In 2001 two new GM cotton varieties were introduced - Round-Up Ready cotton (herbicide tolerant), and Ingard/Roundup Ready Cotton (with both herbicide tolerant and insect resistance genes).

Genetically modified products are generally categorised into three types or 'waves'. The first wave is those products we are already seeing – that is, products with genetic modifications which deliver a benefit to the plant or crop and in most cases, also to the farmer. The second wave of products which we will probably see in the next five to ten years are genetically modified products which exhibit an 'external' benefit. Under this category we will see products with direct benefits for the

consumer, such as fruits and vegetables with increased vitamin content. Finally, the third wave will result in novel products such as plants that contain oils suitable for industrial uses.

From scientific concept to commercial reality

A GM product does not appear in the field or on the supermarket shelf until it has undergone years of research and testing. The average time frame for the development of a genetically modified product is eight to thirteen years.

Research starts in the laboratory and moves into small glasshouses. The laboratories and glasshouses are all registered and must adhere to certain safety standards. Field trials to test the experimental crops developed in the laboratory are the next step. Often, the first field trial may be conducted in an area as small as an average backyard – it takes some years before a project progresses to true field or paddock size.

During field trials, numerous tests are undertaken, not only on the product, but its impact on external factors such as the environment. For example, Ingard cotton was tested to ensure that the introduced protein was specific to the intended pest, and did not harm other insects such as spiders. In addition, tests had to be conducted to ensure the cotton posed no risk to Australia's native cotton varieties.

Depending on the GM crop, different field trial management practices may be implemented. Ingard cotton requires management strategies to prevent target insects from developing resistance to the new protein. Other crops, such as canola, may require management practices such as buffer zones which are established to minimise pollen spread.

The development of a GM product is a lengthy comprehensive process, involving many organisations, and numerous testing phases. In June 2001, Australia's new Gene Technology Act commenced. This Act created the position of an independent Gene Technology Regulator – a high level position which is responsible for regulating gene technology research and development across Australia, working closely with the Commonwealth, State and Territory Governments, the community, research institutions and private organisations. The Act also established three new committees:

- a Gene Technology Technical Advisory Committee (GTTAC) – to provide scientific and technical advice to the Gene Technology Regulator
- a Gene Technology Community Consultative Committee (GTCCC) – to look beyond the science of gene technology to what matters most to people and to advise the Gene Technology Regulator
- a Gene Technology Ethics Committee (GTEC) – to provide advice to the Gene Technology Regulator on ethical issues relating to gene technology.[3]

Depending on the product, other regulatory bodies, may also be involved in the testing and assessment process. For example, if the product is to be consumed, the Australia New Zealand Food Authority (ANZFA) may also be involved in assessing the product.

Food safety

The safety issues surrounding foods from GM plants have attracted considerable attention. In Australia, ANZFA, in cooperation with the Australian Commonwealth, State and Territory Governments and the New Zealand Government, develops food standards and other regulatory measures for Australia and New Zealand.

In July 2000, the Australia New Zealand Food Standards Council (ANZFSC) of Health Ministers agreed to new labelling rules for GM foods. The new food standard requires the labelling of food and food ingredients where novel DNA and/or novel protein is present in the final food. It also

requires labelling of food and ingredients where the food has altered characteristics, effective from December 2001. There are exemptions from this labelling requirement (see section 1F, p.--).

The new standard allows any one ingredient in a food to contain up to one per cent of GM material where its presence in the ingredient is unintended. Food or ingredients labelled "genetically modified" either contain new genetic material or protein as a result of genetic modification or they have altered characteristics – for example changed nutritive values - compared to the conventional food.

The guidelines state, "The labelling on or attached to a package of GM food must include the statement 'genetically modified' in conjunction with the name of that food, ingredient or processing aid."[4]

Where GM food is not sold in a package, for example fruit and vegetables, any information required about the gene technology status of the food must be displayed on the food or in connection with the food display. Some GM foods may require additional labelling. These requirements relate mainly to whether the food has altered characteristics.

Altered characteristics mean that when compared to its conventional counterpart, the GM food is different. It might:

- contain a new factor known to cause an allergic response in some people;
- raise ethical, religious or cultural concerns, for example some people have ethical concerns about moving genes from animals into plants; or,
- have significantly different nutritional or compositional levels.

The GM food labelling laws mean that consumers can distinguish GM foods from non-GM foods and make purchasing decisions on this basis.

Consumer thoughts

Numerous market research studies and telephone polls have been conducted to assess consumer perceptions of gene technology. One of the best sources for accurate information regarding this is Biotechnology Australia. Established in 1999, Biotechnology Australia is responsible for coordinating non-regulatory biotechnology issues for the Commonwealth Government, and seeks to provide balanced and factual information on biotechnology to the Australian community.

Biotechnology Australia's latest gene technology market research findings highlight an acceptance of gene technology in agriculture, but raise some questions about its use in end food products and medical applications. A survey of 1200 people indicated that since 1999, there has been a significant increase in the number of respondents describing plants with pest resistance as a useful application of gene technology for society – increasing from 31 to 37 per cent. Most focus group respondents also felt that plants were already being modified with other plant genetic material and that this is an accepted and established agricultural practice.

In contrast, the survey noted a significant increase in the number of people who believed that using gene technology in food and drink production is a risky application for society – from 67 per cent in 1999, to 73 per cent in 2001. It appears that consumers are not linking crops with the food on their dinner tables, and this may be a key issue for farmers wanting to access this technology in the future. Also, while the results showed concerns about GM food, almost half of the respondents (49 per cent) said that they would still eat foods that had been genetically modified, highlighting that concerns do not always correlate with consumer behaviour.[5]

Moving forward

Gene technology has the potential to deliver good news for world agriculture, including the possibility of higher yielding crops and resulting in more nutritious foods produced in a more

environmentally-friendly and sustainable manner. Ingard cotton is providing Australia with one example of this. With all new technologies, both the benefits and risks must be assessed. This can only occur with on-going research and development, including on-going field trials. For consumers, the critical issue is to seek credible, balanced information on gene technology from trustworthy sources, in order to make informed decisions.

Discussion notes

- Decisions about the development of genetic engineering (GE) and the production of GM crops should be taken in conjunction with a holistic approach to agricultural policies. This context needs to be addressed, namely the need, the motivation and the reasons why GE is being promoted. The main reason seems to be the failure of our 'conventional' food production and distribution systems. Our 'conventional' systems are destroying soil, water, insect and plant balances and GE is fostering a continuation of these systems. As implied by several other contributors to this book, the systems need to change, not the genetic makeup of organisms.
- Higher yields and more nutritious foods? We already produce higher yields of grain than we need. Those who try to apply this so-called benefit to developing countries must never have lived in one and researched that country's bio-history. Each country traditionally has its own diverse food supply and methods for living with their environment. Mono-cropped agriculture that focuses on yields of one product is not the answer, it is the problem. Promoting more monoculture promotes more environmental stresses for the soil, insects, climate and other plants. Monculture also produces mono-diets which can lead to either micronutrient deficiencies or to the need for more supplements and fortification (or in GE's solution, just add a gene or two and get all the nutrients in one plant). What is really needed is more diverse yields of foods that can be harvested in many seasons, can withstand various climatic changes and can provide a variety of different nutrients (see section 2 d). For example, with a diverse diet there is no need for vitamin A or iron in rice, or for foods with a different fat content.
- More environmentally friendly and sustainable? There is nothing more sustainable and friendly to the environment than the environment itself. Food production systems that work with the environment are the closest we can get beyond returning to hunting and gathering in the wild (which is totally impracticable except for a tiny proportion of the Earth's human population). Conventional agriculture needs to wean itself away from high inputs of fossil fuels, chemicals, soil losses, monocultures, waste producing, water wasting, etc. (see section 6b). In short, GE is targetting the symptoms of the root problems rather than the problems themselves.
- The cotton industry employs many people who are committed to improving sustainability. Thus, insect resistant cotton, since its commercial introduction in 1996, has reduced pesticide applications by on average 50per cent per season, in the area under which it is grown. The cotton industry sees this as a real opportunity for Integrated Pest Management, and this technology has delivered substantial benefits, not only to the growers themselves but also to local communities.
- From the environmental point of view, the economic benefits of growing cotton should be weighed against possible ecological hazards. Thus, while it seems sensible to develop disease resistant cotton plants which require fewer insecticides, if this means unrestricted increased planting and production by irrigation, this will impose further stresses on the salinity problem along the Murray Darling basin (see section 6e).
- Another concern is that GM is already being trialed for the production of expensive biochemicals (e.g. the 'biopharming' of the protein avidin). As there appears to be some difficulty in keeping GMO food crops distinct from non-GMO food crops, this could turn into a disaster if biopharm plants at some stage contaminate the food ones.
- Under the new regulatory scheme, the Gene Technology Act, field management guidelines and plans are closely monitored by the Regulator, and those who fail to comply face considerable repercussions. For example, in the case of the GM canola trials, there are in place a number of zones surrounding the GM canola including a pollen trap, monitoring zone and a 400m. isolation zone, and neighbours have to be notified. There is considerable discussion currently taking place – at both industry and government levels – in relation to identity preservation systems, and systems under which all forms of agriculture – including GM, conventional and

organic – can co-exist. It is important that we consider all these issues before we give the 'commercial tick' to any GM product, on a case-by-case basis.

Further reading

1. James C. (2000). Global Status of Commercialised Transgenic Crops. 2000. ISAAA Briefs No. 21: Preview. ISAAA: Ithaca, NY.
2. Fitt, G.P. and Wilson, L.J. (2000) Genetic Engineering in IPM: Bt cotton. pp. 108-125 In: Kennedy, G.G. and Sutton, T.B. (eds). *Emerging Technologies in Integrated Pest Management: Concepts, Research and Implementation*. APS Press, St. Paul.
3. Office of the Gene Technology Regulator at: http://www.ogtr.gov.au
4. Australia New Zealand Food Authority at: http://www.anzfa.gov.au
5. Biotechnology Australia at: http://www.biotechnology.gov.au

**Agrifood Awareness Australia is an industry initiative established in 1999 to increase public awareness of, and encourage informed debate about, gene technology. For further information write to PO Box E10 Kingston ACT 2604 or telephone (02) 6273 9535.*