Know-how for Horticulture™

Horticulture gene technology communication package

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Australia Limited

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HAL

Know-how for Horticulture™

Agrifood Awareness

Gene
technology in Australia

What's happening in horticulture?

HAL

Know-how for Horticulture™

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SETTING THE SCENE

In 2002-03 approximately $4.5 million worth of horticultural projects funded through Horticulture Australia Limited included a biotechnology component. Biotechnology is a modern field of science that will underpin advances in all aspects of plant research and it may deliver new knowledge, technologies and products in the future.

Horticulture Australia's Biotechnology Program aims to help Australian horticulture remain internationally competitive by:

- fostering new partnerships between biotechnology laboratories and conventional breeding programs to deliver developments to industry
- providing knowledge of plant processes and development
- discovering new genes
- discovering new gene technologies
- generating new intellectual property to negotiate international horticultural research & development (R&D) alliances
- encouraging investment in the area.

This booklet aims to present a brief overview of gene technology in horticultural commodities in Australia and highlight examples of research underway. It also provides an overview of the science involved in gene technology, the regulation of gene technology in Australia, current gene technology products in the market, and what some industry groups are thinking in relation to the technology.

Gene technology in Australia: What's happening in horticulture?, is produced by Agrifood Awareness Australia Limited with support from Horticulture Australia Limited.

Agrifood Awareness Australia Limited is an industry initiative, established to increase public awareness of, and encourage informed debate about, gene technology. Agrifood Awareness Australia Limited is committed to providing quality science-based information to encourage informed decision making.

Horticulture Australia Limited is a national research, development and marketing organisation. It works in partnership with the horticulture sector to invest in programs that provide benefit to the Australian horticultural industry. Horticulture Australia Limited receives Commonwealth funds on a dollar-for-dollar basis for R&D activities, while marketing programs are 100 per cent industry funded.

We welcome your comments and questions.
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HORTICULTURE IN AUSTRALIA

Fruits, vegetables, nuts, cut flowers and nursery products make up Australia's horticulture industry, which in 2003 was valued at $6.3 billion (gross value of production).

Total horticultural exports in 2002-03 were $778 million. More carrots, onions and potatoes were exported overseas than any other vegetable, while the top three fruit exports were oranges, grapes and apples.

The top five importers of Australian grown fresh horticultural produce in 2002-03 were Hong Kong, Japan, Malaysia, Singapore and the United States of America (USA).

Horticulture is Australia's second largest rural industry after wheat, and the sector is based on 21,000 farms providing 80,000 jobs.

The average Australian eats approximately 135 kilograms of fruit, and 162 kilograms of vegetables per year.

GENE TECHNOLOGY POTENTIAL

Gene technology has the potential to improve the sustainability, profitability and flexibility of Australian horticulture. Through crops that can protect themselves from pests, diseases and viruses, gene technology may allow growers to produce healthier crops that require fewer inputs.

Industries carrying out or paying for research on pests, diseases or crop disorders may already be using gene technology. Techniques such as molecular markers, PCR, and ELISA (see page 5), which are part of the gene technology suite of tools, are routinely used in plant breeding to improve varieties however their use does not necessarily result in a genetically modified (GM) plant or variety.

IN THE LAB

What is…

… biotechnology?

Biotechnology is the study and use of living things to make or change products.

Food flavourings, waste treatments, antibiotic and insulin production, and cancer treatments are just some examples of modern day biotechnology applications.

Biotechnology includes bioprocessing, gene technology and molecular breeding technologies.

Biotechnology is now a major technology in business and agriculture and a research tool for scientists and plant breeders. The use of biotechnology does not always result in a genetically modified (GM) end product.

… bioprocessing?

Bioprocessing is the term now given to traditional biotechnology processes such as bread and cheese making.

… gene technology?

Gene technology is a tool of modern biotechnology.

It can be used for a range of purposes including enhancing conventional breeding through identifying the functions of genes, or to develop a genetically modified organism (GMO) by introducing, enhancing or deleting particular characteristics depending on whether they are desirable or not.

Gene technology is also known as genetic engineering or genetic modification.

… a gene?

Genes are the coded information that give living things a particular characteristic, such as colour or height. Genes are carried in an organism's DNA, and DNA is in the cells of all living things.

Plants have around 22,000 genes and animals have approximately 30,000-40,000. Gene technology allows the alteration, deletion or movement of as little as one component of a gene to many genes at once.

All living things use the same type of code in their genes, and most of the genes that control basic functions of life – such as growth are essentially the same in all organisms.

… a genetically modified organism (GMO)?

A GMO is a living thing that has been modified using gene technology.

… molecular breeding?

Molecular breeding is biotechnology using molecular markers to speed up or enhance conventional plant or animal breeding programs. Molecular markers are pieces of genetic material that are easily detectable and located near genes of interest. These markers are particularly useful in breeding programs because scientists and breeders can screen for the presence of a specific gene without waiting for them to be expressed. This process does not result in a GM product.

Gene technology tools include:

Gene probes can be used to find a particular gene amongst many thousands, and they are often used to recognise sequences associated with genetic diseases.

Polymerase chain reaction (PCR) allows researchers to find and copy particular genes within a few days rather than the years it took previously. This technique can be used to diagnose diseases and to locate particular characteristics within a cultivar.

Enzyme linked immunosorbent assay (ELISA) is used to detect the presence of antibodies or antigens in biological samples. Antigens include substances such as toxins, viruses and bacteria. These substances stimulate the production of antibodies.

Why use gene technology?

Gene technology is currently used to achieve these main outcomes:

- basic knowledge about genes and how they function
- production of biological chemicals
- controlling viruses
- disease resistance
- insect resistance
- modifying quality characteristics.

Gene technology is already used to produce pharmaceuticals, and research is underway to produce healthier foods and enhance environmental and agricultural sustainability.

Further information:

http://genetech.csiro.au/

AVAILABLE GM PRODUCTS

Local production

Genetically modified **carnations** and **cotton** are produced commercially in Australia. Carnation varieties with blue-violet/mauve colouring are Australia's only commercially available GM horticultural product, and they can be purchased from florists. Carnations with a longer vase-life are being developed.

Traditionally, improvements to the colour of flowers have been obtained by crossing existing varieties. However, for some flower varieties, no amount of traditional breeding will achieve blue, violet or mauve flowers because they do not have the right genes to produce the blue pigment.

Australian researchers overcame this 'blue' hurdle using gene technology. The first GM carnation, launched in 1996 contains genes from petunia and snapdragon flowers, which give it mauve/blue colouring. Four further blue-violet/purple coloured carnations have since been commercialised with more in the pipeline. The technology may be applied to species such as rose, gerbera, lily and chrysanthemum in the future.

Carnations with a longer vase-life are also being developed using gene technology. By inserting an extra copy of a carnation gene into the plant, ethylene production can be prevented, slowing down the deterioration of flowers once they are cut from the plant.

First grown commercially in 1996, GM cotton varieties with in-built insect resistance produce a natural insecticide (Bt) to control a devastating cotton pest, heliothis. The varieties have resulted in, on average, a 45 per cent reduction in pesticide applications each year. Three other GM cotton varieties have since been approved – herbicide resistant, herbicide resistant/Bt, and a further insect resistant cotton. CSIRO scientists predict new GM cottons may further reduce pesticide use by up to 75 per cent.

Further information:

www.ogtr.gov.au

What's happening globally?

In 2004, the global area of GM crops was 81 million hectares, an area equivalent to 15 times the land area of the United Kingdom (UK). The major crops grown were soybean, corn, cotton and canola. The remaining GM crops, squash, potato and papaya represent less than one per cent of the global GM crop area.

Genetically modified crops were grown commercially by more than eight million farmers in 17 countries during 2004, with the majority being grown by the USA, Argentina, Canada, Brazil and China. Besides Australia, other countries growing GM crops include South Africa, India, Spain, Mexico and Germany.

Herbicide tolerant soybean was the most dominant GM crop, grown across nine countries on 48.4 million hectares.

Broadacre crops have been the focus of much of the early gene technology research, and as a result they dominate the current commercial statistics, however research targeting horticultural commodities is underway.

Further information:

www.isaaa.org

Genetically modified papaya, also known as pawpaw, has been approved for human consumption since 1997 in the USA. The GM papaya is commercially produced in Hawaii, and is resistant to the papaya ringspot virus (PRSV). The virus almost destroyed the entire industry in Hawaii, and now the PRSV-resistant papaya represents more than half of the island's crop.

Genetically modified potato varieties resistant to the Colorado Beetle, Potato Virus Y and Potato Leaf Roll Virus were available to growers in the USA, however due to a minimal take-up of the technology, all GM varieties were discontinued in March 2001. Researchers in the USA are now involved in collaborative research with scientists from Russia, to make GM varieties available to small landholders struggling against drought, pests, and diseases.

Squash has also been genetically modified to resist viruses such as the Cucumber Mosaic Virus (CMV). Varieties are marketed to growers in the USA however few are currently being grown.

ENSURING SAFE USE

In June 2001, legislation to regulate the use of gene technology in Australia came into effect. The Office of the Gene Technology Regulator (OGTR) was established to oversee these laws.

The Gene Technology Regulator, a Ministerial Council (comprising state and federal ministers), and three committees comprising of experts from many disciplines and community representatives, are responsible for ensuring that GM products and gene technology research are used responsibly in Australia.

On average it takes eight to thirteen years for a GM product to be developed.

Licences, laboratory approvals and inspections, strict research guidelines and procedures, field trial surveillance and public consultation opportunities are all part of Australia's gene technology regulatory system.

Genetically modified plants and crops are tested for things such as:

- any risks they pose to native or other plants, animals and people. For example, the Regulator considers whether the GM plant could be more toxic or allergenic to people than the non-GM variety or whether the GM plant is more toxic to other organisms in the environment
- their potential to spread pollen (genetic material) to conventional plants or related weed species, in relation to whether there could be adverse consequences of the introduced genetic material spreading into other plants
- their ability to become a weed, and therefore be harmful to the environment, or harder to control than their non-GM counterpart.

All gene technology research projects currently underway in Australia are listed on the OGTR web site.

Commercial release approval from the Gene Technology Regulator for a particular GM crop does not automatically mean commercial production will begin as any relevant state-based legislation must be considered.

Further information:

www.ogtr.gov.au

Developing a GM crop

a potato case study

Low browning potatoes were one of the **first GM horticultural crops** developed in Australia by CSIRO, but they are not currently grown commercially.

Potatoes, and many other fruit and vegetables, go brown when cut or damaged and this reaction results in wastage. Researchers isolated the gene that causes this reaction in 1993 and the following year, they modified the 'Atlantic' potato variety by inserting a back-to-front (anti-sense) copy of the gene.

The plants were then monitored in contained facilities for several years. The modified potato plants grew as expected in glasshouse trials. About 200 minitubers of the GM potatoes were generated and planted out in a single isolated plot.

Field trials help determine how well plants perform in different regions under different weather and soil conditions. Prior to field testing, the GM potatoes were assessed thoroughly to ensure that they were equivalent to non-GM potatoes in relation to safety aspects such as allergenicity and toxicity.

The potato plot was surrounded by a **buffer zone** of non-GM potatoes. Buffer zones ensure that GM material does not spread beyond the trial site. Buffer zone distances usually depend on the size, movement and viability of pollen. Pollen flow is usually not an issue if a trial plot is grown amongst unrelated plants.

Mature GM potatoes were harvested in 1995 and 1996 and tested by mechanical damage and cutting. Excess potatoes were destroyed each year and at the end of the trials all remaining material was destroyed. Spent GM plant material such as prunings, fruit, plants and tubers were also destroyed. The field site was monitored for three years after the trial to ensure no GM plants remained.

Most plants grew normally and had equivalent yields to non-GM plants, but they did not go brown when bruised.

This technology in potatoes is now being further developed in the USA and Europe. The technology is also useful in other crops and researchers are currently applying it to bananas in the UK, pineapples in Malaysia and apples and pears in Canada. CSIRO receives license fees from the organisations using the technology. The international agreements state that the technology remains available to the Australian industry.

In Australia this low-browning technology is being tested in sultana grapes which are undergoing field trials. The result should be lighter coloured dried sultanas. Whether or not these vines are grown commercially will be determined by the OGTR, the Australian industry and community over the next few years.

FOOD SAFETY

Food Standards Australia New Zealand (FSANZ) is responsible for ensuring that all foods are safe to eat. The regulatory agency not only examines GM products developed and grown in Australia, but also assesses food products imported into Australia.

Genetically modified foods undergo very rigorous case-by-case testing. Some of the safety tests on GM foods investigate:

- the function of the new gene
- how the new food will be digested in the human gut
- whether the GM food poses any new allergy risks.

In the pipeline

Initial work involving gene technology in horticulture has focused on delivering agronomic benefits for example virus or disease resistant crops, however there are now a number of research projects around the world looking to deliver consumer oriented products, these include:

- fruits and vegetables with increased nutritional value, for example tomatoes with increased levels of cancer fighting anti-oxidants, or potatoes with higher protein levels
- vaccines for diseases such as Hepatitis B, produced in foods such as bananas and lettuce
- traditional foods with a modified characteristic, for example onions which, when cut, do not cause tears.

Allergies

All GM products are tested for any potential allergens and toxins during the research and assessment phase.

A GM product is allowed to contain the same allergens as its non-GM counterparts. For example, the allergens in a non-GM peanut may still be present in a GM peanut, and would be indicated on the label as per the current labelling requirements for allergens.

Gene technology has the potential to remove allergens from foods, for example removing gluten from wheat or the allergy-causing protein from peanuts.

Toxicology testing

Toxins are poisonsous substances produced by many living organisms, including plants, and are found in many of the foods we eat. The majority of toxins in foods are well below harmful levels. Examples of toxins include the substance found in green potatoes (glycoalkaloids), which can cause immediate illness, and fungal toxins, which sometimes contaminate food.

As toxins are naturally present in many conventional foods, they can also be found in foods that have been genetically modified. Toxicology testing is done on all GM foods to ensure that their toxin levels have not significantly increased above the range of their conventional counterpart. This testing process involves animal feeding studies.

CONSUMER CHOICE AND LABELLING

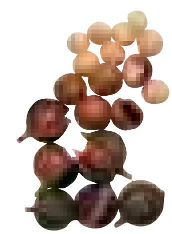
A labelling system for GM foods commenced in Australia in 2001, allowing consumers to identify foods with GM ingredients.

Generally, if genetic material or protein from the genetic modification is present in the final food, at levels above one per cent, it is identified in the ingredient panel of the label. In the future, any GM fruit and vegetables sold will require labels, either directly on the product or displayed in association with the food.

Consumers can recognise new GM foods as they become available, and make purchasing decisions based on this knowledge.

Highly refined products such as oils, foods containing GM flavourings of less than 0.1 per cent of the food content and food eaten in restaurants do not have to be labelled. This rule exists for a number of reasons – for example, in the case of oil, the genetic material is removed in the refining process, meaning that oil from a GM plant is essentially no different to oil from a non-GM plant.

Food products from six GM commodities mainly grown overseas have been approved for use in food sold in Australia, however GM sugar beet and potato varieties are not currently marketed to growers.



Approved GM foods in Australia

Crop	New characteristic	Potential food uses
Soybean	• Herbicide tolerance • High oleic soybean	Soy foods include soy beverages, tofu, soy oil, soy flour and lecithin. Soy may be present in foods such as breads, pastries and snack foods.
Canola	• Herbicide tolerance	Canola oil. Products made with canola oil may include fried foods, baked products and snack foods.
Corn	• Insect protection • Herbicide tolerance • Insect protection and herbicide tolerance	Corn foods include kernels, oil, cornflour, sugar and syrup. Products containing corn may include snack foods, baked goods, fried foods, edible oil products, confectionery and soft drinks.
Cotton	• Insect protection • Herbicide tolerance	Cottonseed oil and linters may be used in blended vegetable oils, fried foods, baked foods, snack foods and edible oil products.
Potato	• Insect protection • Insect protection • Virus protection	Whole potatoes. Products containing potato may include, snack foods, processed potato products and other processed foods.
Sugar beet	• Herbicide tolerance	Sugar beet is processed into sugar which may be used in processed foods.

Source: ANZFA (now FSANZ), 2000

Further information:

www.foodstandards.gov.au

RESEARCH UNDERWAY

There are numerous gene technology research projects on horticultural commodities underway in Australia. Most of the research is being conducted by public institutions such as CSIRO, universities and state government departments. All of these projects are listed on the OGTR website, and most are currently laboratory- or glasshouse-based.

Research projects listed overpage are licenced, undertaken by accredited organisations, and conducted in contained facilities, such as laboratories. They are not released into the environment. To conduct field trials, a new licence accompanied by specific management guidelines must be obtained from the OGTR.

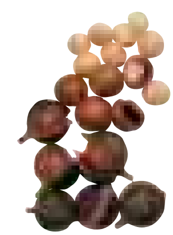
Specific management guidelines for conducting field trials are imposed on a case-by-case basis by the OGTR. For example, field trial approval has been granted for GM pineapples, modified to delay flowering and reduce the incidence of blackheart. Risks considered as part of the risk management and risk assessment process include toxicity and allergenicity for humans and other organisms, the weediness potential of the GM variety and pollen movement from the GM pineapples into the environment. The risks have been categorised as ‘negligible’ or ‘very low’ by the OGTR, however conditions have been imposed as part of the licence agreement. The conditions include fencing the trial sites, preventing the GM pineapples being fed to livestock or entering the food chain, cleaning and monitoring the harvest site for six months after harvest, and removing any volunteer pineapple plants before they flower.

Furthermore, the OGTR may also require certain management conditions to be implemented as part of a commercial approval. In 1996, insect-resistant GM cotton was approved for commercial release. During the development of this GM cotton two main risks were identified - the risk of heliothis developing resistance to the cotton, and the potential for the GM cotton to outcross with native cotton varieties. As a result, licence conditions and/or management practices were imposed. To minimise the chance of heliothis developing resistance to the cotton and therefore extend its effectiveness, a resistance management strategy was implemented, which included the planting of refuge crops (non-GM cotton or another crop) around the GM variety and capping the use of the insect-resistant cotton to 30 per cent of production. To manage the risk of the GM cotton outcrossing with native cottons, the cotton was limited to specified shires in the cotton growing areas of Queensland and NSW, below 22º South. Australian cotton growers successfully implemented these management practices and achieved pesticide reductions of 50 per cent each season using this cotton.

Horticulture research in the pipeline

Commodity	Modification
Banana	Virus resistance – Banana Streak Virus Virus resistance – Banana Bunchy Top Virus (BBTV)
Carrot	Virus resistance – Carrot Virus Y
Celery	Virus resistance – Celery Mosaic Virus
Cucumber	Virus resistance – Cucumber Mosaic Virus
Flowers	Fungus tolerance – Fusarium Colour – isolation of blue genes from various blue flowers for transfer to petunia, rose, carnation and chrysanthemum Increased vase-life in cut flowers - by inhibition of ethylene reception
Fruit	Fruit ripening genes Fruit ripening and flavour development
Lettuce	Virus resistance – Lettuce Necrotic Yellows Virus (LNYV)
Mango	Control of fruit ripening Investigating and identifying the genes involved in the initiation and control of flowering
Papaya	Virus resistance – Papaya Ringspot Virus (PRSV) type P Fruit ripening – control
Pineapple	Control of blackheart in pineapple
Pome fruits	Disease resistance – Fire blight resistance in apples and pears
Potato	Virus research – Potato Virus Y and Potato Virus X Synthetic resistance genes to Potato Leaf Roll Virus (PLRV)
Tomato	Virus resistance – Tomato Leaf Curl Virus Ripening characteristics – for example, increasing the sugar levels in the ripening tomato
Tropical Fruit	Identify and characterise gemini viruses associated with tropical crops in Vietnam
Vegetables	Fungus resistance – Clubroot fungus Insect resistance – Diamondback moth resistance in brassicas
Wine grapes/ Grapevine	Table grape genetics/wine grape genetics Fungal contaminants and their impact on wine quality Early diagnosis of eutypa dieback in grapevine Molecular breeding of grapevines for resistance to major root pests

Source: OGTR, 2003



Further information:

www.ogtr.gov.au

Key genes for horticultural markets

The pooling of gene technology projects is becoming a new way to provide generic solutions to specific problems for even the smallest of industries.

A project investing in generic gene technology research titled 'Key genes for Horticultural Markets' commenced in 2001. The $1.5 million research project undertaken by CSIRO Plant Industry aims to identify valuable genes for horticultural crops. The three project target areas are the genes involved in:

- fruit set and seed formation
- the size and shape of a number of plant organs
- the colour and mouth feel of foods.

If this research proves to be successful, providing industry with useful characteristics for horticultural commodities, industry must then discuss individual applications of the research and whether commercialisation will be pursued through the costly gene technology regulation process. Such decisions typically involve discussions regarding the potential research outcome, consumer perceptions regarding the potential product, and the willingness of commercial partners to bring the product to the market.

Building international partnerships

Australian researchers are also collaborating with colleagues overseas, on a large range of projects based on understanding the action and interaction of genes in organisms. The involvement of Australian researchers in these projects means that Australian growers will have access to useful results from the work.

The table below highlights a number of projects underway in the USA.

Commodity	**Modification**
Apple	*Bacteria resistance – Fire Blight*
Broccoli	*Insect resistant (Bt)*
Citrus	*Virus resistant – citrus tristeza virus*
	Bacteria resistant – citrus canker
Eggplant	*Insect resistance (Bt) - Colorado Potato Beetle*
Grape	*Bacteria resistance – Pierce's Disease*
Lettuce	*Herbicide tolerant - glyphosate*
Peanut	*Insect resistant – the lesser cornstalk borer*
Pineapple	*Nematode resistant*
Potato	*Herbicide tolerant – glyphosate*
	Fungus resistant – verticillium wilt
Raspberry	*Virus resistant – Raspberry bushy dwarf virus*
Stone Fruit	*Virus resistant – plum pox*
Strawberry	*Herbicide tolerant - glyphosate*
Tomato	*Herbicide tolerant - glufosinate*

Source: NCFAP, 2002

A different breeding tool

the macadamia case study

Researchers are using molecular markers, a tool of gene technology, to improve the speed and success of the breeding program of Australia's most important native food crop, the macadamia, through:

- increased efficiency of breeding new cultivars by eliminating progeny without desired traits
- identifying new diversity for incorporation into the breeding program.

'DNA typing' allows researchers to locate certain sequences of genes on the DNA that are unique to particular cultivars. Each cultivar has a distinctive pattern and these patterns can be compared quickly to find relationships and similarities. This technique will allow the industry to validate or accredit newly developed cultivars before they become established in the industry.

Plant breeding aims to 'concentrate' favourable characteristics into a few cultivars by crossing different parents to improve cultivar performance. In the long term DNA markers will help to identify the **parents** with the best potential genetic characteristics and the presence of the genes in the breeding population.

DNA marker technology can also **short cut plant improvements** by identifying 'linkages' to some important characteristics. For example, if a cultivar-specific marker associated with 'large nut size' can be identified then it can be used to produce populations where the 'large nut size' character has been concentrated. The search for associations with useful characteristics will cover plant features such as early fruiting, ease of harvest and disease resistance, or nut features such as high kernel recovery, long shelf-life, or better oil content.

To find these useful linkages researchers can only work with varieties where some pedigree information is available. Identifying linkages to good characteristics will also be extremely helpful in selecting parents of greater breeding value. Cultivar-specific **markers** can also be used to identify lines that contain undesirable characteristics such as disease susceptibility which can then be bred out of new cultivars.

Macadamia gene banks – collections of trees developed from wild populations - have been planted at three sites in Queensland and New South Wales. They are the culmination of many years work by botanists, researchers and the industry to find, assess and preserve the most diverse range of macadamia genetic material possible.

DNA typing has been used to 'scan' these wild macadamia populations in order to understand their relationship to the cultivated varieties. It has also facilitated the identification of genetic diversity not previously accessed by macadamia breeders, whose current range of industry cultivars are based on a limited number of parents. Markers have also been used to assess the long term genetic viability of wild stands of macadamia to determine their long term conservation future and value.

Apart from speeding up breeding programs, DNA typing offers **benefits** such as:

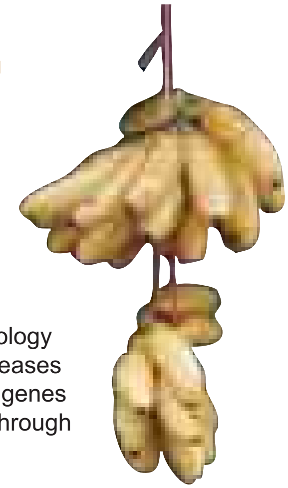
- cultivar identification or verification
- pedigree analysis or tracing parentage
- monitoring pollen flow for improved orchard design
- identifying unique populations in the wild for long term preservation
- kernel testing.

This technology will potentially help in plant authentication, plant improvement, orchard management and product quality control.

Further information:

www.csiro.au

RESEARCH IN THE SPOTLIGHT



In Australia

Bananas of the future

Australia is part of an international 'Bio-Banana' project consortium, which is using gene technology to locate genes for resistance to Bunchy Top, Black Sigatoka and Panama disease. These diseases have the potential to wipe out entire varieties in Australia. The project is currently focusing on genes from within the banana genus. Bananas are sterile plants and almost impossible to breed through conventional means.

Further information: www.abgc.org.au

Quality control in pineapples

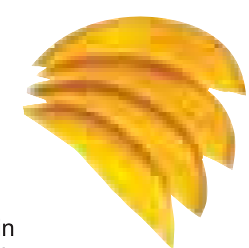
Research is underway using gene technology in pineapples in Queensland to both delay flowering in order to reduce harvesting costs and to reduce blackheart, a postharvest discolouration caused by low temperatures during cultivation or storage. Adverse environmental conditions can cause pineapples to flower by inducing the plant's production of ethylene. This can cause harvesting costs to escalate for growers who may be faced with pineapples in one field flowering at all different times. By preventing ethylene production using gene technology, and physically applying ethylene at the right stage of the plant's development, uniform flowering and therefore ripening can be achieved. Field trials for these two projects are underway.

Further information: www.dpi.qld.gov.au/horticultureresearch
www.uq.edu.au

Seedless citrus

A citrus project utilising gene technology was one of the first involving a horticultural crop in Australia. The research project showed that two genes originally found in model plants - one that results in fewer seeds and another which interferes with seed development - had the same effect when inserted into West Indian limes. The lime fruit from the GM trees had significantly less seeds, or smaller, soft seed traces. Work in this area is currently pending the development of methods to successfully transform and regenerate commercial varieties, in conjunction with overseas laboratories.

Further information: http://genetech.csiro.au



Managing flowering

Research is underway to identify the genes involved in the initiation and control of flowering in citrus, mango and grapes. This work aims to understand and develop methods to predict and manage flowering and the processes involved in the plant's switch from vegetative growth to the development of flowers.

Further information: www.csiro.au

Around the World

Improved banana production

Researchers are using biotechnology to improve banana production for small-scale banana producers in Kenya. Widespread soil degradation and infestations of pests and diseases in orchards have led to a severe decline in banana production – threatening food security, employment, and incomes in banana-producing areas.

The broad goal of the project is to make clean planting materials of improved banana varieties available to farmers. Field trial results to date have been very positive, with plants showing a significant improvement in growth and yield compared to conventional varieties.

Further information: www.isaaa.org

Strawberries without weeds

Weeds are the biggest management problem for the growers in Northeast USA where production is largely based, and they cause more losses than insect and disease pests combined. Using gene technology, researchers have inserted a bacteria gene into strawberries, which allows them to be resistant to the herbicide glyphosate, that is, they are not killed if they come into contact with glyphosate applied to the weeds around them. Economists predict the herbicide tolerant strawberries could almost halve herbicide use, and save more than US$1 million annually in the area's production costs such as manual hand weeding and cultivation.

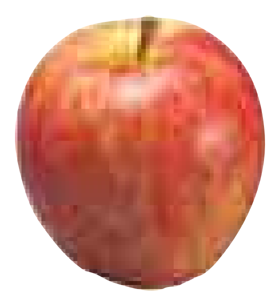
Further information: www.ncfap.org

Protein-packed potatoes

The latest GM product announced with enhanced nutritional benefit is also targeting developing countries. As reported in *New Scientist* magazine in January 2003, Indian scientists have developed the 'protato', a protein-rich potato. The 'protato' contains a gene from the amaranth plant, a plant grown by South Americans, and commonly available in Western health food stores. The new gene allows the potato to produce a third more protein than non-GM potatoes, including the essential amino acid lysine. A lack of lysine can affect brain development in children.

The 'protato' research is part of an 'anti-hunger' plan developed in collaboration with charities, scientists, government institutes and industry, currently under consideration by the Indian government. The 15-year plan aims to combat childhood mortality by providing children with clean water, better food and vaccines. The 'protato' is in the final stages of safety, environmental and dietary testing before being submitted for regulatory approval.

Further information: http://news.bbc.co.uk/1/hi/sci/tech/2980338.stm



Fighting fire blight

Fire blight is one of the most devastating bacterial disease to affect apples worldwide. An outbreak in the USA in 2000 caused losses estimated at US$42 million including US$9 million in tree losses. Using gene technology researchers have produced apple lines of 'Royal Gala' resistant to fire blight under field trial conditions. The GM lines contain a gene from the silkworm moth pupa.

Further information: www.ncfap.org

MONITORING CONSUMER OPINION

Comprehensive tracking of consumer responses to biotechnology and GM foods has been undertaken in Australia by the federal government agency, Biotechnology Australia. Findings from two major surveys released in 2001 and 2003 are listed below.

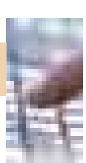
Question	2001	2003
Do you think biotechnology will improve our 'way of life' over the next 20 years?	51% said yes	
Is the use of gene technology in food and drink production perceived as useful?	57% perceive it as useful	51% perceive it as useful
Is the use of gene technology in food and drink production perceived as risky?	73% perceive it as risky	74% perceive it as risky
Is the use of gene technology in food and drink morally acceptable?	59% agree	53% agree
Would you be willing to eat GM food?	49% said yes	45% said yes
Would you eat GM fruit and vegetables if they were modified to be healthier?	60% said yes	50% said yes
Would you buy GM fruit and vegetables if they were modified to taste better?	43% said yes	38% said yes
Use of GM medicines	60% would use them	59% would use them
Sources of information on gene technology	Television - 78% Newspapers – 76%	Television - 69% Newspapers – 71%

Further findings of the market research include:

- in 2003, only 18 per cent of respondents agreed that there are 'no fresh fruit and vegetables produced in Australia using gene technology'.
- in 2001, many respondents were under the impression that when it comes to agricultural products there is organic and there is everything else. That is, respondents felt that much of the food and drink they currently consume is genetically modified.
- seventy-three per cent of respondents believed that they require more information about the technology in 2001.

Further information:

www.biotechnology.gov.au



Europe

The 2001 Eurobarometer survey, undertaken by the European Commission, of 16,029 people from 15 European countries, found that:

- fifty-nine per cent believe they understand what GM foods are
- when it comes to buying GM food, 94 per cent of people wanted the right to choose
- GM foods were believed to be dangerous by 56 per cent of respondents
- seventy-one per cent of respondents rejected GM foods completely.

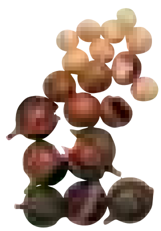
Further information: http://europa.eu.int/comm/public_opinion/archives/eb/ebs_154_en.pdf

United Kingdom

A survey of more than 3000 people across the UK in 2002 by the government's Food Standards Agency (FSA), revealed that consumers are becoming more aware of healthy eating and what food labels mean. The survey showed that consumers are most concerned about issues such as food poisoning, bovine spongiform encephalopathy (BSE) and pesticides. The level of concern about food containing GM ingredients had fallen, with 25 per cent of respondents in 2000, and 17 per cent in 2001 claiming to look for information about GM on food labels.

GM foods ranked behind food poisoning (59 per cent), BSE (55 per cent), animal feed and pesticides (50 per cent), as a food concern with 38 per cent of consumers worried (down from 43 per cent in 2000).

Further information: http://www.food.gov.uk/multimedia/pdfs/consumeratt_uk



Asia

In 2002, a GM food survey of 600 Chinese, Indonesian and Filippino consumers found that:

- sixty-six per cent of consumers believed that they would personally benefit from GM foods in the next five years
- ninety per cent of those who believed they had eaten GM foods recently, were satisfied with this situation, and took no action to avoid it
- over 80 per cent of those surveyed were willing to try a snack containing GM ingredients when it was offered to them
- the main disadvantages listed by respondents in relation to food biotechnology were potential side effects, the potential cost of the technology to farmers, and the addition of chemicals harmful to the body.

The survey was commissioned by the Asian Food Information Centre (AFIC), an organisation established to communicate science-based information about food.

Further information: http://www.afic.org

INDUSTRY PERSPECTIVES

Apple & Pear Australia Limited (APAL)

APAL, as the peak industry body representing all apple and pear growers, through research and development partnerships is committed to exploring opportunities in biotechnology with the objective of providing safe and environmentally sustainable products to the domestic and overseas consumer.

(From: APAL, formerly AAPGA, GMO Policy 2000)

Australian Citrus Growers Incorporated (ACG)

ACG is committed to exploring new developments in all areas of science and applying these where there are clear benefits to consumers and acceptance by society. No GMOs are currently used in the production of Australian citrus fruit.

(From: ACG Position on Gene Technology, April 2002)

The Australian Banana Growers Council (ABGC)

The banana industry currently funds banana research involving gene technology. The main focus has been on overcoming diseases. Some of the potential benefits growers look for in relation to gene technology in bananas include virus, fungal and nematode resistance and a reduced reliance on pesticides. The main industry concerns raised in relation to the use of gene technology are consumer perceptions of gene technology and international trade issues.

(From: *'Guiding Meaningful Opinions'* Horticulture Newsletter, Agrifood Awareness Australia, October 2001)

Strawberries Australia

Gene technology is not being used by the Australian strawberry industry and currently ranks very low on the list of priorities for Australian strawberry growers. The main research and development priorities relate to developing high yielding varieties suited to Australian conditions with a high consumer appeal. Gene technology may in the future offer benefits such as longer shelf-life, pest resistant varieties and increased vitamin content of the fruit, but consumer acceptance of GM products is a major factor for the industry.

(From: *'Guiding Meaningful Opinions'* Horticulture Newsletter, Agrifood Awareness Australia, December 2001)

Australian Processing Tomato Research Council (APTRC)

In relation to gene technology research, the APTRC has adopted a GMO free approach. It believes that consumers are not ready for GM tomatoes in Australia, and as a result, it is not currently funding such research. The APTRC is tracking consumer perceptions on this technology by watching what is happening in other industries internationally and consumer responses.

(From: *'Guiding Meaningful Opinions'* Horticulture Newsletter, Agrifood Awareness Australia, June 2002)

Tasmanian Pyrethrum Growers Commodity Group

The pyrethrum industry is not using gene technology in research and development programs and does not have a gene technology policy. The industry is however very aware of the issues surrounding gene technology, and is monitoring the commercial, scientific and community views on the topic. Pyrethrum is a small industry, and at this stage there is no commercial imperative to consider investing in gene technology research.

(From: *'Guiding Meaningful Opinions'* Horticulture Newsletter, Agrifood Awareness Australia, December 2002)

INFORMATION SOURCES

Gene Technology Regulation
Office of the Gene Technology Regulator - OGTR
www.ogtr.gov.au
Phone: 1800 181 030

Food Regulation
Food Standards Australia New Zealand - FSANZ
www.foodstandards.gov.au
Phone: (02) 6271 2222

Gene Technology - A Comprehensive Overview
Agrifood Awareness Australia Limited - AFAA
www.afaa.com.au
Phone: (02) 6273 9535

Biotechnology Australia – BA
www.biotechnology.gov.au
Phone: 1800 631 276

CSIRO
http://genetech.csiro.au
Phone: 1300 363 400

Industry
Horticulture Australia Limited
www.horticulture.com.au
Phone: (02) 8295 2300

ABOUT US

Agrifood Awareness Australia Limited

Agrifood Awareness Australia Limited, launched in May 1999, is an industry initiative, established to increase public awareness of, and encourage informed debate about, gene technology.

Agrifood Awareness Australia Limited is committed to providing quality, factual information on the application of gene technology. We believe it is critical for individuals to have access to credible, balanced, science-based information in order to make informed decisions.

Agifood Awareness Australia Limited is supported by Avcare, the Grains Research and Development Corporation and the National Farmers' Federation.

If you would like more information about gene technology research, regulation and developments, please contact:

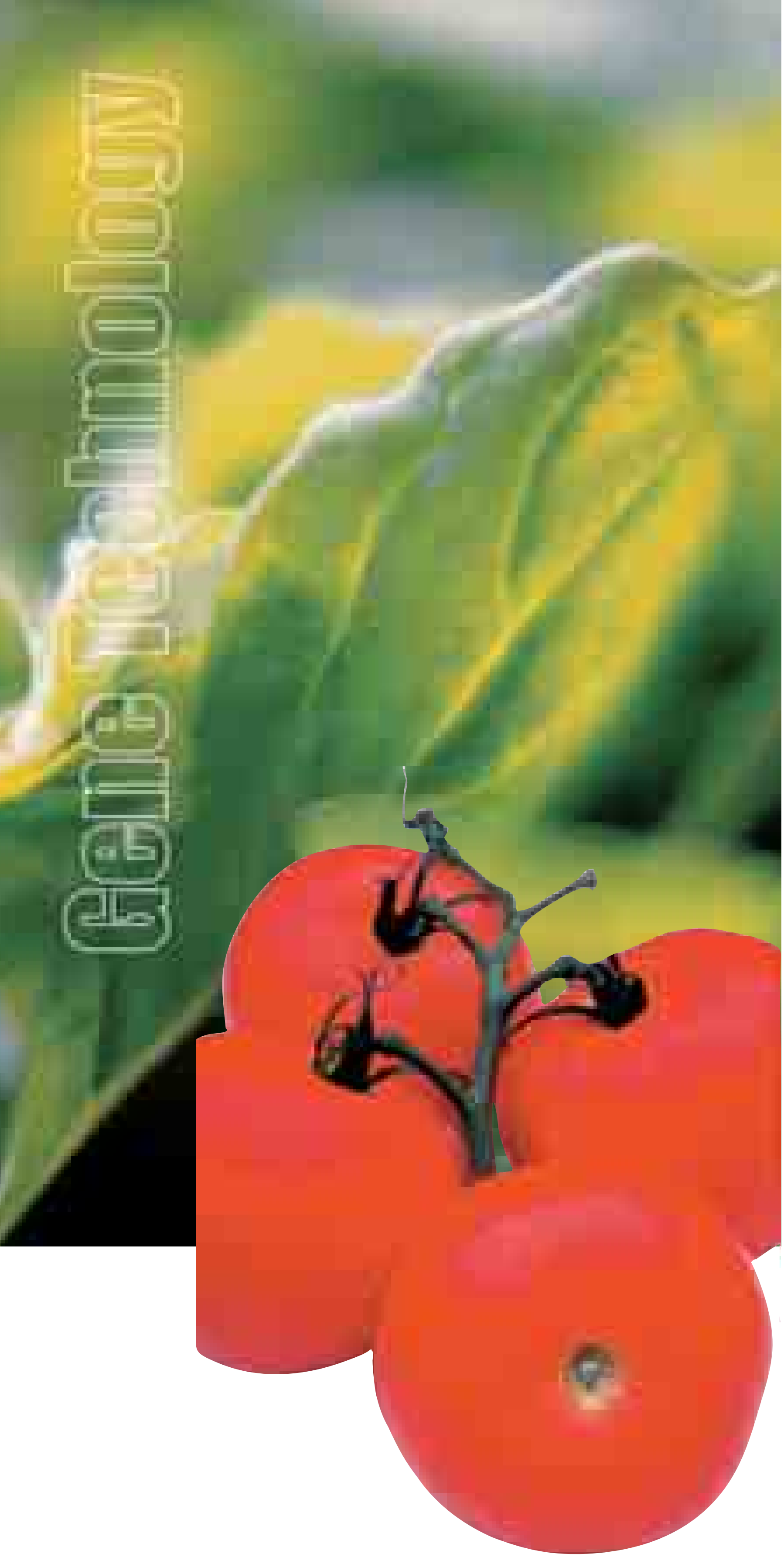
Agrifood Awareness Australia Limited
Phone: (02) 6273 9535
Email: info@afaa.com.au
Web site: www.afaa.com.au

Horticulture Australia Limited

Horticulture Australia Limited is a national research, development and marketing organisation. It works in partnership with the horticulture sector to invest in programs that provide benefit to the Australian horticultural industry. Horticulture Australia Limited receives Commonwealth funds on a dollar-for-dollar basis for R&D activities, while marketing programs are 100 per cent industry funded.

If you would like more information about Horticulture Australia Limited,
please contact:

Horticulture Australia Limited
Phone: (02) 8295 2300
Email: info@horticulture.com.au
Web site: www.horticulture.com.au



Agrifood Awareness

Tastier tomatoes

The first GM whole food approved for commercial sale was the FLAVRSAVR tomato released in the USA in 1993. The tomato had been modified, by reversing an existing tomato gene, to slow down the ripening process. The idea was to improve the flavour of the tomato, by allowing it to stay on the plant longer, yet still maintain its firmness for transport purposes.

While the project was a success, an unsuitable variety was used and as a result, the fresh tomato did not succeed in the marketplace.

In the UK, GM tomatoes also with delayed ripening properties were available as canned tomato puree, and labelled as genetically modified. They sold competitively against conventional brands until growing public concern resulted in their removal from sale.

HAL

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