Agrifood Awareness AUSTRALIA Limited

Biotech Bulletin 9

GM Cotton Adoption

Welcome to this edition of Agrifood Awareness Australia Limited's (AFAA) Biotech Bulletin. This edition of the Biotech Bulletin, entitled "GM Cotton Adoption" summarises the development, commercialisation and adoption rates of genetically modified (GM) cotton varieties in Australia and overseas.

INTRODUCTION

Cotton researchers and growers will converge on the Gold Coast next week for the 12th Australian Cotton Conference. The conference entitled "Quality Cotton – A Living Industry, Not Just Another Yarn" aims to bring leading farmers, researchers and industry from Australia and overseas together to discuss the cotton industry. Conference delegates will be updated on the international scene and hear the latest advances in managing new technology.

This conference presents a timely opportunity to review the introduction and adoption of GM cotton varieties in Australia and overseas.

BACKGROUND

There are approximately 20 million cotton farmers worldwide. In 2003, 30 million hectares of cotton was planted globally, producing 84 million bales. Cotton is grown in the hotter regions of approximately 65 tropical/subtropical and temperate countries around the world.

Globally, ten countries accounted for 80 per cent of the total cotton area planted in the 2001/2002 season. The balance of 20 per cent was grown in 55 countries, as follows:

	COUNTRY	'000 HECTARES
1.	India	8,730
2.	USA	5,596
3.	China	4,824
4.	Pakistan	3,125
5.	Uzbekistan	1,453
6.	Brazil	750
7.	Turkey	654
8.	Turkmenistan	550
9.	Mali	516
10.	Benin	415
	TOTAL	26,613 (80%)
	Others	6,844 (20%)
	WORLD TOTAL	**33,457**

Source: ISAAA

Cotton is principally grown for the production of clothing. It is also used for products such as cotton buds, and less known products like bank notes, x-rays, soap and upholstery. Cotton seed is pressed to extract the oil from it, and this oil is used for frying. The hull (shell) of the seed produced from the cracking of the seeds to separate the kernels and pieces is used as stock feed. The stalk of the cotton plant is processed for the development of ethanol for petrol and diesel blends and is also used as a mulch to improve soil.

Facts

- One cotton bale which weighs 227 kilograms can produce 215 pairs of jeans, 249 single bed sheets, 765 men's shirts, 1,217 t-shirts, 2,104 pairs of boxer shorts, 3,085 nappies, 4,321 pairs of socks or 681,000 cotton balls.
- Cottonseed now ranks second in terms of world oilseed production, behind soybeans.

AUSTRALIA'S COTTON INDUSTRY

Australia is the major producer of cotton in the Southern Hemisphere and the world's third largest exporter of raw cotton (1999-2000). Production from the Australian crop has been over three million bales for the last few years. Australia is seen as a reliable supplier of high quality cotton on the world market.

Cotton is one of Australia's most significant agricultural industries, with the country exporting nearly 90 per cent for use in clothing and fabrics. Australia's cotton producers produce the highest yields in the world with the industry worth approximately $1.7 billion a year.

In the 2001/2002 season Australia exported 90 per cent of its cotton primarily to Indonesia (27 per cent or 854,000 bales), Japan (17 per cent or 533,000 bales), South Korea (13 per cent or 414,000 bales) and Thailand (13 per cent or 397,000 bales).

There are around 1,700 growers in the cotton growing areas of NSW and Queensland. In the 2002/2003 season, Australian growers produced just 1,650 million bales on 220,000 hectares – less than half that produced in a 'normal' season, due to serious drought conditions. Of this 1,250 million bales were baled in NSW and 400,000 in Queensland.

Disease and insect resistance

Australia's cotton crops are attacked by a number of insect pests, but the major ones are the caterpillars of the cotton budworm (Helicoverpa [previously Heliothis] armigera) and the native budworm (H. punctigera) and occasionally spider mites.

The caterpillars cause damage early in the season, whereas the native budworm causes more damage later in the season. Pest pressures together with increasing concern about the use of chemicals led to the development of insect tolerant GM cotton varieties.

GM insect-resistant cotton

In 1996, insect-resistant GM cotton was grown commercially for the first time in Australia. This followed six years of field trials and approval for release by the Genetic Manipulation Advisory Committee (GMAC), which has since been replaced by the Office of the Gene Technology Regulator (OGTR).

Known as Bt or Ingard Cotton, the cotton contains a gene from the soil bacteria *Bacillus thuingiensis* (Bt), which allows the plant to produce the Bt protein which kills the caterpillar when it eats the leaves.

Like all GM crops, insect resistant cotton underwent a thorough regulatory assessment. During the development of Bt cotton three main risks were investigated – the risk of heliothis developing resistance to the cotton, the potential that the Bt cotton could outcross with native cotton varieties, and the impact of Bt cotton on non-target insects. The latter risk was noted to be unlikely, but the first two risks were identified as possible and resulted in licence conditions and/or management practices.

To minimise the chance of heliothis developing resistance to the cotton a Resistance Management Strategy (RMS) was implemented. An on-farm component of the RMS was that refuge crops were to be grown with all Bt cotton. These required the planting of refuges of non-GM unsprayed cotton or other plants (ie. sorghum or maize) where the insect pests can breed freely. It provided a population of susceptible insects to dilute out resistance genes if these developed in the insect pests.

In addition, the Australian Pesticide, Veterinary Medicines Authority (formerly the National Registration for Agricultural and Veterinary Chemicals) and the Australian cotton industry capped Bt cotton production at 30 per cent of the industry to preserve the effectiveness of the product by guarding against the evolution and emergence of resistance insects.

To manage the risk of Bt cotton outcrossing with native cotton varieties, particularly in northern Australia the cotton was limited to specified shires in the cotton growing areas of Queensland and NSW, below 22º South.

For further information on the licence and regulatory approval for Bt cotton visit:
http://www.ogtr.gov.au/rtf/ir/dir022finalrarmp.rtf

Adoption rates
The area of Bt cotton in Australia increased from 30,000 hectares in the 1996/1997 season to reach, in regulated annual increases of five per cent, 165,000 hectares (a maximum of 30 per cent) in the 2001/2002 season.

Recent media reports quoting Dr Gary Fitt, a Director of CSIRO Entomology, have noted that Bt cotton "was the quantum leap forward for the industry. After six years experience growing Ingard cotton in Australia, farmers have been able to reduce aerial spraying against caterpillars by up to 56 per cent compared with conventional cotton." Dr Fitt also notes "that Bt cotton has allowed growers to become more confident with managing their pests in softer ways."

According to CSIRO, since the adoption of Ingard cotton, chemical use such as endosulfan, has been reduced by 90 per cent.

Another insect resistant cotton
To build on the success of Ingard cotton in Australia, scientists developed GM Bollgard II cotton varieties with even greater pest resistance. Bollgard II was approved for commercial release in 2002 and became available to cotton growers for planting in the 2002/2003 season.

Bollgard II was developed by inserting two genes from the soil bacterium Bt into cotton, which built on the single Bt gene contained within Ingard. These genes produce two separate proteins in the leaves of the cotton plant and when cotton's major caterpillar pest eats the plant, it dies.

Field trials determined that cotton yield and quality from Bollgard II varieties is comparable to that of conventional non-GM varieties. According to CSIRO, Bollgard II varieties have reduced pesticide use by 75 per cent in field trials.

As part of the transition to the Bollgard II varieties, in the 2003/2004 season both GM varieties (Ingard and Bollgard II) were available for planting. In the season following (2004/2005) Ingard will be withdrawn altogether to minimise the exposure of the single gene in Ingard and to reduce the risk of resistance developing.

According to CSIRO, in the 2004/2005 season it is likely the cap of 30 per cent on insect resistant GM cotton will be removed. It is anticipated that Bollgard II will occupy up to 50 per cent of the total cotton area in the 2004/2005 season, however growers are required to follow the Bollgard II Resistance Management Plans. The percentage area planted to Bollgard II is limited by the amount of refuge crop that growers need to plant for resistance management purposes. This varies depending on what refuge option is used.

Further information visit:
CSIRO www.csiro.au/index.asp?type=faq&id=Bollgard&stylesheet=divisionFaq
OGTR: httwww.ogtr.gov.au/ir/dir012.htm

GM Herbicide tolerant cotton
Roundup Ready cotton and Roundup Ready/Ingard (Bt) cotton (combing both herbicide tolerance and insect resistance), were commercially available in Australia in 2001. The latter is produced through the conventional breeding of Roundup Ready cotton and Ingard cotton. Roundup Ready cotton plants are genetically modified to be tolerant to the herbicide glyphosate. Herbicide tolerant crops are not affected by the herbicides applied to the weeds around them, providing growers with an additional tool for improved weed control options.

Herbicides typically used on Roundup Ready cotton crops pose a lower risk to the environment than herbicides commonly used on conventional crops. In addition, it is suggested that the weed control programs used with Roundup Ready cotton allow reduced tillage and fewer applications of residual

herbicides, providing further environmental benefits. This has been further reported this week in a study released by Sydney University. (see: http://www.agric.usyd.edu.au/research/p/2003.htm)

The percentage of Roundup Ready cotton grown in Australia exceeded 40 per cent for the 2003/2004 cotton season.

For further information on the regulatory approval of Roundup Ready cotton visit: http://www.ogtr.gov.au/ir/dir023.htm

Other GM cotton research
In addition to the commercially released GM cotton varieties mentioned above, a number of varieties are currently undergoing field trials in Australia with various characteristics including: insect-resistance, herbicide tolerance and high oleic acid content. High oleic acid oils have a healthier fatty acid profile, and are expected to be more stable for frying purposes without the need for extra processing (hydrogenation). For further information see: www.ogtr.gov.au/gmorec/ir.htm

GLOBAL ADOPTION
The total area grown to GM cotton in 2002 was 6.8 million hectares, a significant increase from 2001. By 2003, 21 per cent or 7.2 million hectares of the 34 million hectares of cotton grown globally was of a GM variety. This was an increase of 20 per cent from the total area in 2001 and is equivalent to 11 per cent of the total global GM area, according to the International Service for Acquisition of Agri-biotech Applications (ISAAA).

Insect resistant cotton
Genetically modified Bt cotton was first introduced in the USA in 1996 and grown on 730,000 hectares. China first adopted the technology in 1997 with less than one million hectares grown, by 2001 this amount had increased to 1.5 million hectares.

The area of Bt cotton globally had doubled by 1998 to 1.5 million hectares and was grown in a total of six countries - USA, Mexico, Australia, Argentina, China and South Africa. By 2001, up to five million farmers grew Bt cotton, of which 99 per cent were in developing countries.

In 2002, there were nine countries with commercialised Bt cotton varieties, two developed countries (USA and Australia) and seven developing countries including three Asian countries (China, India and Indonesia), three from Latin America (Mexico, Argentina and Colombia) and South Africa.

In 2002, India, the largest cotton-growing country, which accounted for 25 per cent of the global area, grew 50,000 hectares of Bt cotton for the first time. By 2003, the amount increased to approximately 100,000 hectares. Cotton accounts for approximately one-third ($8.5 billion) of India's total export earnings ($34 billion) either directly or indirectly through textiles and clothing, and thus has very important financial implications.

The Federation of Indian Chambers of Commerce and Industry observed that GM crops offer the potential for huge productive gains and that "if the kind of productivity increase seen in China, is possible in India, then genetically modified crops hold a lot of promise for Indian agriculture." The Federation believes that GM technology could help alleviate some of the challenges in increasing the productivity of Indian agriculture, the foundation of India's rural economy.

According to the ISAAA, in India Bt cotton has the potential to reduce the requirements for cotton insecticides by half. Insecticide savings at the farmer level are likely to be significantly greater because farmers often apply unnecessary insecticide applications.

A very high percentage (>97 per cent) of cotton farmers in developing countries farm about two hectares or less, with farmers in north and east China growing, on average, less than 0.5 hectares. Bt cotton has been a very positive investment for resource-poor small cotton farmers in China, according to the ISAAA. The result has been a sustainable reduction in the number of insecticide poisonings by farmers.

According to the ISAAA, China has made a major public sector R&D investment into crop biotechnology, including cotton, estimated at $112 million per annum in 1999. This is equivalent to more than half of all corresponding R&D expenditure on crop biotechnology in the developing world.

China has further committed to increase its crop biotech R&D budget by 400 per cent by 2005 to $450 million.

Currently, there are between four to five million small farmers in about 30 developing countries which have not adopted Bt cotton. The ISAAA states, "this technology can make a significant contribution environmentally, economically and socially, and in particular to the alleviation of poverty and improved health of small resource-poor farmers." (see: www.isaaa.org/kc/)

Insect resistance/herbicide tolerant
In 1997, GM stacked gene cotton varieties, containing the Bt and herbicide tolerant genes were grown in the USA. According to the ISAAA, by 2001, the stacked gene cotton variety accounted for 55 per cent of all the global commercial cotton containing the Bt gene, compared with 45 per cent of the single Bt gene.

Cotton approved
Cotton has been approved for various uses in a number of countries world-wide. Insect resistant cotton has received regulatory approval in the following countries:

APPROVED FOR	COUNTRY
Food	Argentina, Australia, Canada, China, Japan, Mexico, South Africa, USA.
Feed	Argentina, Australia, Canada, China, Japan, Mexico, South Africa.
Food and/or Feed	USA
Environment (planting)	Argentina, Australia, Canada, China, India, Japan, Mexico, South Africa, USA.

Source: AGBIOS 2003

Herbicide tolerant cotton has received regulatory for its various uses in the following countries:

APPROVED FOR	COUNTRY
Food	Argentina, Australia, Canada, Japan
Feed	Argentina, Canada, Japan
Food and/or feed	Australia, USA
Environment (planting)	Argentina, Australia, Japan, USA

Source: AGBIOS 2003

THE FUTURE
According to ISAAA, significant advantages can be seen in terms of environmental, economic and health benefits by the introduction of GM cotton. Taking into account the global distribution of cotton by area and production, it is evident that developing countries are major players and potentially stand to gain from any technology that will decrease cost of production, increase productivity and income and reduce pesticide use.

FURTHER INFORMATION
Agrifood Awareness Australia Limited's Resource Guide – GM cotton in Australia: www.afaa.com.au
Cotton Australia: www.cottonaustralia.com.au
Cotton Research and Development Corporation: www.crdc.com.au
CSIRO: www.csiro.au
International Service for Acquisition of Agri-biotech Applications: www.isaaa.org
International Service for Acquisition of Agri-biotech Applications Knowledge Centre: www.isaaa.org/kc
Office of the Gene Technology Regulator: www.ogtr.gov.au
12th Australian Cotton Conference - Gold Coast: www.crdc.com.au

We look forward to your feedback on this newsletter.

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