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Impact of Genetically Engineered Cotton in the World

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Biotechnology is the latest addition to the tools used by researchers and in particular by breeders to improve productivity of crops. According to the International Service for Acquisition of Agri-Biotech Applications (ISAAA), transgenic crops were planted on 52.6 million hectares in the world during 2001/02. No such data are available for 2002/03 but all indications are that the transgenic crops area will further increase in the current season. Over the last six years, since 1996/97, the transgenic crops area in the world has increased by 30 fold. Genetic engineering technology has been accepted at a faster rate compared to any other technology in agriculture.

A number of crops have been transformed but cotton, soybean and maize occupy 95% of the total area. Other crops include canola, potato, squash, papaya and many others planted on less than 5% of the transgenic area in the world. Soybean is 63% of the total area followed by maize on 19% and cotton on 13%.

Fifteen countries have gone into commercial production of transgenic crops. Only four countries i.e. Argentina, Canada, China (Mainland) and the USA grew 99% of the total transgenic crops area in 2001/02. The U.S. planted 68% of the world transgenic area followed by Argentina 22%, Canada 6% and China (Mainland) 3%.

Efforts have been made to improve a number of traits in various crops. But, insecticide and herbicide resistance are still the only two traits used on commercial scale apart from virus resistance and others planted on less than 1% of the total transgenic area. Herbicide resistance is the most popular character occupying 77% of the total transgenic area, 15% of the total area is under Bt gene crops while stacked genes for herbicide and insect resistance occupied only 8% of the total area. Stacked gene varieties are available only in cotton and maize.

Since the initiation of commercial production of Bt cotton in 1996/97, transgenic cotton has been commercialized in 8 countries. They are Argentina, Australia, China (Mainland), India, Indonesia, Mexico, South Africa and the USA. Indonesia planted only a few thousand hectares for the 2nd year in 2002/03 and India planted Bt hybrids for the first time in 2002/03. Bt cotton in India has been introduced only through commercial cotton hybrids and it is estimated three commercial cotton Bt hybrids were planted on 40,000 hectares during the current season. In Mexico, 50% of the total area was planted to transgenic varieties in 2002/03; both insect and herbicide resistant varieties are permitted for cultivation.

Insect and herbicide resistant transgenic cotton was planted on 77% of the total area in the USA and 74% of the area in South Africa in the current season. Almost half of the total area was under transgenic varieties in China (Mainland) during the current year. China (Mainland) is the only country where two sources of transgenic genes are used against insect resistance. It is estimated that about 2/3 of the total transgenic area was planted to transgenic varieties developed from the local Bt gene while 1/3 had the Bt gene which is used in other countries.

Herbicide resistant transgenic varieties are permitted for commercial cultivation in Argentina, Australia, South Africa and the USA. In other countries only Bt cotton has been approved for commercial production. This was the first year of herbicide resistant transgenic cotton in Argentina, Australia and South Africa. In the USA, where over four million hectares were planted to transgenic varieties in 2002/03, 50% of the area was planted to herbicide resistant varieties, 48% to stacked gene herbicide and insect resistant varieties while only 2% was planted to Bt varieties. The technology fee in the USA is as follows:

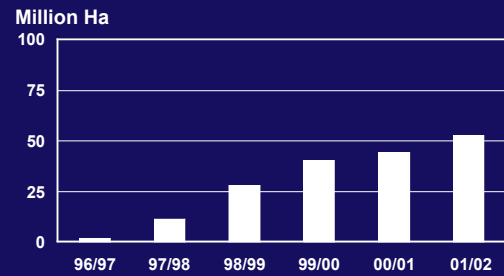
Bt cotton varieties	US\$80/ha
Roundup Ready	US\$17-22/ha
BXN	US\$15-25/ha
Bt + RR	US\$101/ha

The technology fee is related to the savings in the insecticide use, thus the fee in Australia where the number of sprays is more than the USA, was also higher. Originally it US\$154/ha which was lowered to US\$116/ha and now it is US\$98/ha for Bt cotton. In South Africa the technology fee for a 25 kg bag of planting seed, which is enough to plant one hectare was US\$60/ha for four years. The plans were to increase the fee by US\$10/ha in the current year. As the fee is dependent on the savings in insecticide use, so it may or may not be economical to grow transgenic Bt cotton under all production conditions. The economic benefit will vary on the pest pressure and pest complex. If a country does not have a major threat from bollworms and budworms, it will not be economical to grow Bt cotton under those conditions. It is also important to note that the extent of economic benefits may be different for different production conditions or countries depending upon the number of sprays required to control boll and budworms. The benefit from the Bt gene may also vary year to year as the pest pressure varies from year to year. Thus, the two factors that will determine the usefulness of Bt cotton for many countries will be the technology fee and the cost of pesticides used to control pests targeted by the Bt or any other gene meant to control those pests.

TERMINOLOGY MISCONCEPTION

- **Biotechnology**
 - Involvement of living organisms
 - bio pesticides, etc
- **Genetically Modified Organisms (GMO)**
 - Conventional breeding, mutation breeding
- **Genetically Engineered (GE)**
 - Recombinant DNA Technology

TRANSGENIC CROPS AREA - WORLD



GLOBAL AREA OF TRANSGENIC CROPS 2001/02

Trait	Mil. Ha	Percent
Herbicide tolerant	40.6	77
Insect resistant (Bt)	7.8	15
Bt + herbicide	4.2	8
Virus resistant/others	<0.1	<1

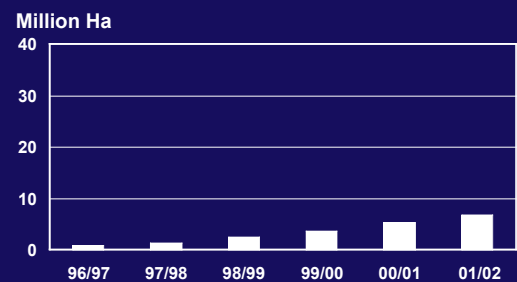
AVAILABLE TRANSGENIC COTTONS

1. **Herbicide resistant**
 - A. Buctril (Bromoxynil) - BXN cotton
 - B. Roundup Read (Glyphosate) - RR cotton
2. **Insect resistant - Bt cotton**
 - Ingard - Australia
 - Bollgard - USA
 - Bt cotton
3. **Herbicide + insect resistant - Stacked gene**

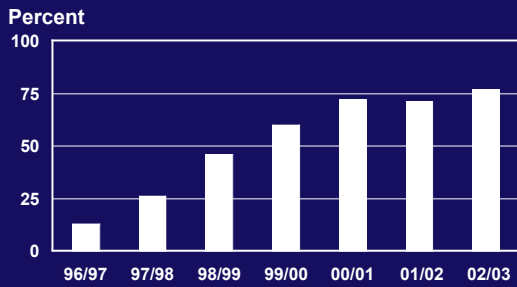
TRANSGENIC COTTON GROWING COUNTRIES

Argentina	Bt + Herbicide
Australia	Bt + Herbicide
China (M)	Bt
Indonesia	Bt
India	Bt (Hybrids)
Mexico	Bt
South Africa	Bt + Herbicide
USA	Bt + Herbicide

TRANSGENIC COTTON AREA - WORLD



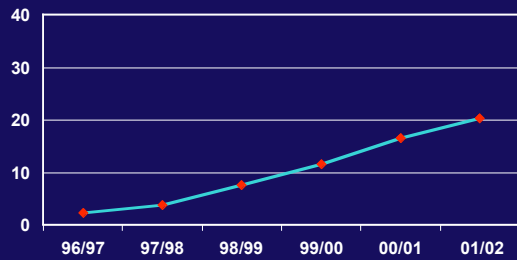
TRANSGENIC COTTON AREA - USA



TRANSGENIC COTTON AREA - 2002/03

Year	GE Cotton
Argentina	5%
Australia	30%
China (Mainland)	45%
Mexico	25%
South Africa	74%
USA	77%

TRANSGENIC COTTON AREA - WORLD



GE COTTON IN CHINA (Mainland)

Sources of Gene (Area in %)

Source	1997	1998	1999	2000	2001
CAAS	20	25	31	36	38
Monsanto	80	75	69	64	62

GE COTTON IN THE USA - 2002/03

Character	Area in %
Herbicide resistant - BXN	2%
Herbicide resistant - RR	35%
Total =	37%
Bt + RR	37%
Bt	3%

TECHNOLOGY FEE (Bt)

Year	Australia	South Africa
1996/97	154/ha	-
1996/97	154/ha	-
1997/98	116/ha*	60/ha
1998/99	98/ha	60/ha
1999/00	98/ha	60/ha
2000/01	98/ha	60/ha

* Also had a rebate if resistance management requirements complied fully.