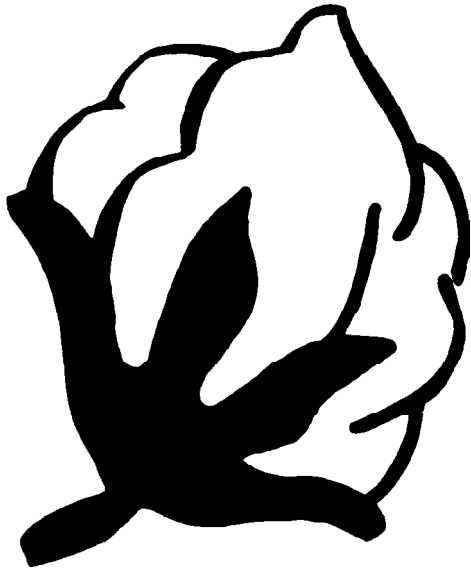




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- **Update on cotton production research**
- **Nouvelles recherches cotonnières**
- **Actualidad en la investigación de la producción algodонера**

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Introduction

In the last few years, Argentina has emerged as the largest cotton producing country in the MERCOSUR region. Over a million hectares were grown to cotton during 1997/98 under low input and rainfed conditions with minimum pest pressure. Government programs have facilitated mechanization of farming and cotton production by large growers. Argentina has a great potential to increase area under cotton and also improve yields. Cotton production conditions and prospects for further development have been reviewed in the first article.

In the 2nd article the situation of transgenic cotton in the world has been discussed. After two years of cultivation in Australia and the USA, Bt cotton is now spreading to other countries. It is estimated that about 60,000 ha have been cultivated to Bt cotton in Australia in the current season. In 1998, Mexico and South Africa will also grow Bt cotton on a commercial scale. Many new varieties have been developed, and Delta and Pine Land Company has extended programs to 16 countries. The Bt gene with herbicide tolerance in the same variety will be available for production in 1998. It seems that many countries will grow Bt cotton in the next few years.

An article "Cotton ginning—A need for a new technology" was published in the June 1994 issue of *THE ICAC RECORDER*. The newest technology at that time was cage ginning as it applied a technology different from roller and saw ginning. The work on cage ginning is still continuing, with a focus on removing all fibers from seed to eliminate the need for residual

ginning. Now, a private company has developed a new technology in the UK. The machine is called the Templeton Rotary Gin, and basic design of the machine comprises a horizontal flat disc, eight fixed knives radiating from the center and eight leather segments or pouches. The machine is claimed to be less expensive, efficient and cost saving. Details on these new ginning techniques, together with updated information on gin monitoring and control and cost of ginning, are found in the third article of this issue.

A DIALOG search of the CAB Abstracts database on "contamination" is given at the end.

The 6th Meeting of the Latin American Association for Cotton Research and Development (ALIDA) was held in Sáenz Peña, Argentina, from December 1-5, 1997. The meeting was attended by delegates from Argentina, Brazil, Bolivia, Ecuador, Nicaragua, Paraguay, Uruguay, CIRAD - CA and ICAC. Many local participants and researchers from the USA also attended the meeting. A three-member group from Plato Industries, USA, participated and presented a report on the performance of their Attract and Control Tube in the region. Dr. William McGovern from the USDA and Dr. Kater Hake of Delta and Pine Land Company presented papers on boll weevil control and field performance of Bt cotton. Country reports and special papers by delegates from all countries discussed for five days all aspects of cotton production. During the meeting, one day was devoted to discuss the activities of the ICAC/CFC project "In-

tegrated pest management of the boll weevil in Argentina, Brazil and Paraguay." The meeting elected Mr. Aldo Ricciardi of Argentina as the new president of ALIDA and decided to hold the next meeting in Bolivia or Ecuador. Mr. Ricciardi can be contacted at the following address.

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Since the World Cotton Research Conference-2 was announced in early January 1997, over 400 researchers from 48 countries have pre-registered. The revised brochure is now available from the ICAC and from Greece. Some information from the brochure is reproduced on the back cover.

Cotton Production and Research in Argentina

Argentina has the largest cotton producing area in Latin America. It is expected that cotton will be grown on 1.1 million hectares during 1997/98, with total production expected to reach 425,000 tons of lint. Only seven years ago (in 1990/91), cotton area in Brazil was larger than that in all other countries together in the region.

Cotton Production in South America - 1997/98

Countries	Production 000 tons	Area 000 ha	Yield Kg/ha
Argentina	425	1,100	386
Bolivia	37	65	572
Brazil	425	925	459
Colombia	36	50	710
Ecuador	2	5	435
Paraguay	95	230	413
Peru	43	77	566
Venezuela	11	25	456
Total	1,074	2,477	423

One million hectares of cotton are scattered in nine states in the Northwest and Northeast Regions. Chaco is the largest cotton producing province contributing over 60% of total production in the country. In the last five years, cotton area has more than doubled in Chaco, Salta, Santa Fe and Santiago del Estero provinces. In general, Argentine agriculture is characterized by large-scale farming. It is estimated that about 37 thousand farmers are involved in cotton cultivation in Argentina and most of them are large growers.

Cotton Area by Province in Argentina 1996/97

Province	Area (000 ha)
Salta	36,500
Catamarca	2,500
Santiago del Estero	216,400
Tucumán	640
Northwest Region	256,040
Corrientes	14,900
Entre Rios	2,000

Chaco	556,500
Formosa	16,000
Santa Fe	37,500
Northeast Region	626,900

Cotton area has increased since 1990/91 in both Argentina and Bolivia due to a number of policies designed to keep farmers from migrating to urban centers, to inform and educate them about the dynamics of cotton market and due to the strengthening of extension activities. In Bolivia, financing of the cotton crop by ADEPA (National Association of Cotton Growers) also encouraged cotton cultivation. In Argentina, the increase in area is the result of lower input costs and mechanization of farming operations.

Reduction in Cost of Production

Costs of chemicals and machinery are now significantly lower than they were in the mid 1980s, while labor costs have doubled.

Cost of Inputs and Services in Argentina

Input	Unit	1984 Cost in US\$	1996
Seed	Kg	0.76	0.78
Acephate	Kg	117.90	21.06
Cypermethrin	Lit	57.01	19.90
Trifluralin	Lit	9.90	4.50
Urea	Kg	0.55	0.38
Defoliant	Lit	19.20	6.63
Tractor	100 HP	42,300.00	28,470.00
Sprayer		3,023.00	1,490.00
Harvester	Two row	206,800.00	86,700.00
Labor	Day	5.60	10.50
Mechanical harvesting	Ton	120.45	80.00

Source: Cotton Production Prospects in Argentina, by Guillermo Sempronii of INTA, Argentina, in *COTTON: Review of the World Situation*, ICAC, Vol. 50, No. 5, 1997.

Insect Pests of Cotton

The boll weevil was first recorded in Argentina in 1993 in the Puente Tancredo Neves area in the province of Misiones, close

to the Paraguayan border. Its appearance was not in the area growing cotton but it quickly spread to the cotton area in Misiones and, in 1996, that state government decided to ban cotton because of the heavy risk from the boll weevil. In Corrientes and Formosa provinces, the pest was first recorded in April and June 1996, respectively.

Although the boll weevil *Anthonomus grandis* is a new pest and not in the major cotton regions in Argentina, cotton continues to be affected by a variety of other insects, e.g. *Alabama argillacea*, *Frankliniella paucispinosa*, *Horcias nobilellus*, *Eutinobothrus brasiliensis*, *Aphis gossypii*, *Platyedra gossypiella* and *Helicoverpa* species. Fortunately, the insect pressure is not very strong and insecticide use is minimal. About 75% of total spray operations are by heavy spray machinery involving tractor-mounted and aerial spraying.

Diseases are usually not a problem in Argentina, and no chemicals are required to control diseases. Damping off, wilting caused by fusarium or nematodes and bacterial blight may show up some years. Blue disease, whose cause is not known, is controlled by varietal resistance and control of aphids, a vector in its spread. Seed may be treated with chemicals to avoid damping off but breeders always try to maintain host plant resistance to wilting and bacterial blight in new varieties.

Development of Varieties

Varieties are largely developed by the public sector. The National Institute for Agricultural and Animal Husbandry Technology (INTA), under the Secretariat of Agriculture, Animal Husbandry and Fisheries (SAGP), is responsible for all research on cotton at the national level. INTA is also responsible for dissemination of information to farmers through extension workers. State governments and private consultants also undertake extension activities. The main center for research activities on cotton is located at Sáenz Peña, in Chaco, the largest cotton-producing province. There are three other research stations at El Colorado, Reconquista and Santiago del Estero in the provinces of Formosa, Santa Fe and Santiago del Estero respectively.

Most commercially grown varieties have been developed by INTA in Argentina. Only approved varieties are recommended for cultivation. There is a formal variety approval process under the control of the federal government. On average, about 95% of seed requirements are met locally and less than 5% of

the seed is imported. Imported varieties have to be tested and formally approved by the government for commercial cultivation.

Some Pima varieties are also grown on a small area. All varieties are resistant to blue disease. Cacique was grown on a commercial scale for the first time in 1995/96 and has proved to be very suited for cultivation in fusarium affected areas. INTA provides basic seed to cooperatives and private companies for multiplication and distribution. The National Institute on Seed Research (INASE) is responsible for monitoring seed quality. Some provinces buy seed in big lots and provide it at a subsidized price to growers.

Growing Practices

Average farm size in Argentina is about 70 hectares. Only 10-15% of total growers use animal traction to cultivate cotton. About 90% of total production is under non-irrigated conditions. Input use is very low and phosphorous and potassium are never applied. Nitrogen, if applied, does not exceed 40 kg/ha. On average, about 65% of the total corn area, which is a competing crop with cotton, is fertilized. The following three factors are mainly responsible for non-fertilization of cotton.

- The local fertilizer industry is not developed in Argentina. Most fertilizers have to be imported and are thus expensive.
- Recommendations from research do not strongly support application of fertilizers, due to dryland conditions.
- Machinery for fertilization is not available. Cropping intensity is low in Argentina and crops may be rotated in the same field after a couple of years, also reducing the need for fertilizers.

Mechanical picking has been adopted at a fast rate during the 1990s. It is estimated that now there are 726 pickers in Argentina and about 90% of total production is machine picked.

Number of Picking Machines

Year	Machines
1988	36
1994	95
1995	335
1996	669
1997	726

Cotton Varieties Grown in Argentina					
Variety	Ginning Outturn (%)	Length (2.5% mm)	Strength (g/tex)	Micronaire	Uniformity (%)
Guazuncho 2	42.6	28.6	27.0	4.2	6.2
Pora	39.6	28.0	26.0	4.4	6.2
Gringo	39.2	29.0	29.0	4.0	6.5
Mataco	38.3	28.4	19.7	4.7	
Chaco 520	36.0	31.3	31.0	4.0	6.4
Cacique		28.6	27.0	4.8	6.3

30 of the 726 machines have been manufactured locally, while the others have been largely imported from the USA and are of the brand John Deere, which has local repair facilities. More than half of the total machines are two-row pickers. Since 1991, import taxes on agricultural machinery have been reduced to encourage mechanization, and the government has allowed imports of used machinery, including pickers.

Locally produced picking machines were developed from a prototype of a picking machine designed by INTA. A private company successfully fabricated a two-row picker and at least six machines have been exported to Brazil, in addition to selling 30 machines locally. The latest model "Sapucay" is suitable for small and medium sized growers. Unlike spindle picking, Sapucay has a dry picking system. The machine runs on a 60 HP motor compared to 140 HP in case the of two-row John Deere machines. In Argentina, plant height is short due to lack of water and nitrogen fertilizers, and the local machine is said to be more suitable. Although the efficiency of the machine will vary depending on yield level, on average it will cost US\$20/1,000 kg seedcotton/ha to use. The cost of the machine

is equivalent to that of imported machines, but additional benefits are lower operational costs, suitability to local growing conditions and higher efficiency. The company is also working on developing four-row machines.

Yield Prospects

Yields are not high in Argentina, limited by the lack of fertilizer use and adequate water. Increases could likely be achieved by extending irrigation to the cotton areas. Average yields will tend to rise as new growers gain experience with the crop. Continued vigilance against the boll weevil will be required to prevent yield losses.

Bt Cotton is Spreading

The most efficient and cheapest way of controlling insects without insecticide use is the use of in-built genetic resistance in the plant. Unfortunately, strong genes are rarely available within the cotton genome, which could make the plant immune against one or a number of pests at the same time. In the absence of such a genetic resistance, chemical control was advocated as an interim solution to the problem until alternate methods to provide equivalent control become available. Researchers have been looking for such methods and techniques to exploit them on commercial scale. Since the Bt gene technology showed potential for genetic control to lepidopteran insects, researchers have relied on transformation technology for successful production of genetically altered plants.

Methods of Transformation

In cotton, for insertion of foreign genes into the plant, the agrobacterium-mediated transformation has been the dominant method at least during the 1980s. Unfortunately, the use of the agrobacterium-mediated transformation was limited due to genotypic specificity. Once a foreign gene has been inducted into a certain genotype, that genotype should be capable to form a plant-let from callus tissue. From the experience of working with genotypes in various countries, researchers concluded that some Coker types from the USA and some Siokra types from Australia were able to regenerate plants from the callus tissue more successfully than any other genotype. People started using Coker and Siokra types with the agrobacterium method for transforming cotton varieties. Thus, first the desired gene is transformed into a Coker or a Siokra type and then, through back crossing, the same gene is transferred into the desired commercial genotype. Fortunately, the desirable gene did not carry any undesirable linkages and 3-4 successive back crosses converted the desired commercial variety into a transformed genotype. Now, from the commercially available Bt cottons, it has been proved that at the end of the third back cross about 94% of the Bt gene effect is transferred in the recurrent parent.

Genotypic specificity of the agrobacterium-mediated transfor-

mation method tempted researchers to continue working on alternate methods for induction of foreign genes. Direct transformation of meristems with agrobacterium and transformation using particle acceleration are some of the other options, which were explored during the 80s. Direct transformation of the plant parts would eliminate the need for transferring genes via Coker or Siokra genotypes. Elimination of backcrossing means expediting the transformation process by at least three years. Among all options available for direct transformation of meristems, particle acceleration showed most promise for future success and attracted attention of private companies. According to Stewart (1991) only two laboratories in the USA were actively engaged in cotton transformation using the particle gun method in the early 90s: Hans Bohnert at the University of Arizona and John Finer at Ohio State University. Now, in every country having a program on genetic engineering of cotton, public sector research frequently uses the particle gun method for transformation of genes.

Benefits of Genetic Engineering

Utilization of the genetic material carried by chromosomes, genes and more specifically the DNA structure has existed even before researchers knew the secrets of heredity. However, since the fundamentals of inheritance of characters became known about a hundred years ago, breeding approaches applied some fundamental principles for transfer of characters from one genotype to the other. In order to apply and make use of the information, there has always been a need to understand the genetic control of a character. Genetic control of many characters is still not properly understood. Of characters, probably yield is of utmost important which is claimed to be a quantitative character and almost impossible to be transferred according to the wishes of the breeders. Utilization of information on genetic control of characters was also limited by location of characters in close vicinity with others (desirable and undesirable) on the same chromosome, an important disadvantage in conventional breeding in all crops and especially so in cotton.

Genetic engineering provides a tool for manipulation of a single gene or a group of genes coming from another genotype of the same species, a far relative or even a different living organism, including plants and animals. Since genetic engineering of cotton started, the following two areas have progressed most rapidly.

- The use of insecticides has increased to the extent that it resulted in high production costs and resurgence of secondary pests. Production of toxins from within the plant for resistance to insects, particularly bollworms, was the most promising area of research in biotechnology.
- Herbicides can be used before planting or after planting but in either case it is not sure what weeds will show up in the field and in what intensity. Herbicides cannot be applied after germination, when composition of the weed complex and level of weed infestation are known, as they will also kill cotton seedlings/plants. Thus, resistance to broad-spectrum herbicides was another area of high interest for researchers.

Insect Resistance

It is difficult to control bollworms, which enter into the bolls and are least exposed to the insecticides. Bt cotton is a solution to this problem as the toxin, protein in nature, is distributed throughout the plant. For the same reason, Bt corn has also proved to be very successful against European corn borer. NuCOTN 33^B and NuCOTN 35^B were the first Bt cotton varieties released for commercial production. They both belong to the Delta and Pine Land Company and were developed from varieties already in commercial production. More than 40 DPL Bt cotton varieties are expected to be available in 1998, but they all carry the same *B. thuringiensis* gene.

Herbicide Tolerance

Herbicide tolerance can be generated through over production of the enzyme system that is affected by the herbicide or it could also be a production of a specific enzyme within the plant that detoxifies the chemical and the cotton plant no longer remains sensitive to the herbicide. There could be other means of developing tolerance to herbicides in the cotton plant but currently only two herbicide groups are in the limelight and they are both available on a commercial scale in many varieties of cotton. Calgene in collaboration with the Stoneville Pedigree Seed Company has developed varieties resistant to bromoxynil that have been marketed under the trademark BXN cottons. Delta and Pine Land Company in collaboration with Monsanto has developed varieties resistant to glyphosate (Roundup Ready, RR).

Stoneville Pedigree Seed Company offered bromoxynil resistant varieties BXN 57 and BXN 58 for commercial cultivation during 1996/97. Both varieties together were grown on about 20,000 ha in the USA during 1996/97. BXN 58 was replaced with BXN 47 during 1997. It is estimated that BXN 47 and

BXN 57 were grown on over one hundred thousand hectares during 1997/98.

Roundup Ready transgenic cotton was grown on 329,000 hectares in the USA during 1997 and it is expected that area may double during 1998. There were some problems with Roundup Ready cotton in the USA during 1997 as some fields showed excessive shedding and deformed bolls. About fifty farmers in Arkansas and Mississippi have filed claims against Monsanto and the Delta and Pine Land Company, responsible for distributing seed, for losses that they attribute to genetically modified cotton, including abnormal boll formation as well as plants that dropped bolls.

Neither Monsanto nor Delta and Pine Land Company have experienced such abnormalities during the course of experimentation. Currently, no scientific explanations for excessive shedding and malformation of bolls are available yet. The problem is being investigated by Monsanto and Delta and Pine Land Company, and early observations show that excessive shedding may be related to the timing and level of Roundup Ready application on the crop. The affected growers are only a small percentage of the total growers who planted Roundup Ready cotton, and there is still a strong faith in the technology.

According to the November 1997 issue of the Biotech Reporter, the US Environmental Protection Agency has granted a blanket exemption for Roundup Ready technology from tolerance requirements for all plants. Tolerance requirements are more important for food crops where herbicide residue has to be kept below certain limits to avoid any health risks. But, blanket exemption for the Roundup Ready technology will enhance the utilization of glyphosate over the top of other crops

Transgenic Cotton in the USA

In the USA, which is the first country to grow Bt cotton on a commercial scale in the world, Bt cotton had to have approval from the USDA, the US Environmental Protection Agency (EPA) and the US Food and Drug Administration (FDA). All regulatory formalities were completed by the end of 1995, and Bt cotton was first grown on a commercial scale in the USA during 1996/97. Practically herbicide tolerant cotton varieties trademarked as BXN also entered into commercial scale production the same year. Roundup Ready herbicide tolerant varieties were planted on a commercial scale in 1997.

Transgenic cotton having a gene from the soil bacteria *Bacillus thuringiensis* (Bt) is now well known to a majority of the cotton farmers in the USA. During 1997/98, Bt cotton resistant to lepidopteran insects was grown on about one million hectares in the USA. Last year, early season premature reports indicated inability of the Bt gene to produce sufficient toxin and provide desirable control against bollworms. But, end of the season reports confirmed effectiveness of the Bt gene and farmers concluded benefits in using transgenic cotton. Thus, area under Bt cotton increased by 60% in 1997 in the USA and unlike the previous year, there were no reports against Bt cotton with

Bollgard gene resistant to bollworms particularly the tobacco budworm, *Heliothis virescens*.

A number of Bt genes are available which can be used to confer resistance to a variety of pests. The fundamental phenomenon is based on the abilities of a particular gene to produce a specific chemical injurious for pests attacking the cotton plant. It is preferred that a desirable chemical is produced in a specific part of the plant but no such genes are available yet. It would be even more desirable that a single gene be capable to produce such a chemical(s) with a strong effect against more than one insect. From the currently available genes, none is capable to control all species of bollworms. However, the degree of effect on many species varies.

Herbicide tolerance and resistance to insects are not the only areas of research under exploration. There are many other avenues being researched mostly by the private sector. A detailed article "More Genetically Engineered Cottons" was published in the December 1996 issue of *THE ICAC RECORDER* on thermal properties of cotton. Herbicide tolerant and Bt cotton will continue to be used on a large scale but it is expected that the following new genes will become available for commercial production in the near future.

Year Transgenic Cotton

1998	Herbicide tolerant BXN gene and Bt gene resistant to lepidopteran insects will become available in the same variety.
1999	Second generation of Bt cotton (with a different Bt gene) will become available.
2002	Boll weevil protected cotton will be grown.
2003	Naturally colored cotton may be grown. Blue color may be the first to become available after brown and green already available in the normal varieties.
2004	Thermal properties, improved fiber quality and leaf curl virus resistance and many new transgenics are expected.

Programs in Other Countries

Many countries have developed programs in genetic engineering. Outside the USA, most programs are in the public sector

organizations. The program involves five important stages as follows:

- Identification of suitable gene or genes which are capable of producing desired action/chemical upon insertion into the cotton plant.
- Availability of desired lab facilities and technology for transformation of cotton.
- Testing of transformed genotypes.
- Government approval for commercialization.
- A system to produce and distribute seed under strict control.

Herbicides are not used commonly in many countries and consequently Bt cottons resistant to insects have a larger market. It will take many years for countries other than Australia and the USA to develop their own transgenic varieties. These countries have two choices: Wait for a few years and develop and grow their own transgenic varieties on a commercial scale, or pay the technology fee and immediately start growing the presently available varieties. Some countries, due to their specific growing conditions, cannot grow varieties from other countries and will have to develop their own programs.

Plantings in other countries are as follows:

Australia	1996/97	30,000 ha
	1997/98	60,000 ha (estimated)
China (Mainland)	1996/97	137 ha
	1997/98	4,000 ha
	1998/99	30,000 ha
Mexico	1996/97	13,000 ha
	1997/98	20,000 ha
South Africa	1996/97	Trials
	1997/98	400 ha
USA	1996/97	600,000 ha
	1997/98	980,000 ha
Zimbabwe	1996/97	Trials

DPL has now 11 programs in 16 countries. The countries where they have tried their varieties include Argentina, Bolivia, China (Mainland), Colombia, Greece, Mexico, Paraguay, South Af-

Insects	Bt Genes and their Effects on Various Insects							
	Genes							
	CryIAb	CryIaC	CryIB	CryIC	CryID	CryIF	CryIIA	CryIII
H. zea	XXX	X	?	No		No	XX	
H. virescens	XX	XXX				XX	XX	
S. littoralis	No	No		XXX	X	X		
P. gossypiella	XXX	XX	?	No			X?	
A. argillacea	?	XXX						
A. gossypii								
A. grandis								
Eutinobothrus spp.								No
Conotrachelus spp.								?

rica and Zimbabwe. India, where DPL and Monsanto are working separately, may also have some experiments in the field on Bt cotton during 1998. Contacts are also being developed in Pakistan to explore the market for Bt cotton. DPL is working with Monsanto, and they are willing to share their transformed genotypes/varieties with other countries. In order to use the technology, other countries have to pay a fee for the benefit they will gain in savings on insecticides.

The fee for BXN varieties is based on the seed by weight which is calculated at about US\$15/ha for all varieties with bromoxynil resistant gene. The fee for the Roundup Ready resistant varieties is about US\$12/ha.

The technology fee for Bt cotton with a Bollgard gene was about US\$80/ha in the USA and US\$245/ha in Australia. In the USA, the technology fee for the Bt + Roundup Ready seed was US\$100/ha.

The difference in the technology fee in the USA and Australia for the Bollgard gene is related to the benefit in the form of savings in production costs. It is estimated that USA growers will save at least US\$80/ha worth of insecticides by planting Bt cotton resistant to lepidopteran insects. Because using conventional varieties the Australian growers have to spend more on spraying (10 sprayings per season), savings are larger in the case of planting Bt cotton and thus the technology fee is higher.

Monsanto signed contracts with all Bt cotton growers in the USA and Australia. The Australian contracts included compensation to Bt cotton growers if the cost of controlling insects exceeded conventional practices, a provision which was not included in US contracts.

How the private seed companies will be able to keep seed control in countries where landholdings do not exceed a few hectares per family is still not very clear. Growers in many countries keep their own seed. There could be a one-time fee and varieties and genes could be changed frequently. Genes have to be changed because of development of resistance to the toxin. Plant variety protection laws have to be strengthened in countries interested in growing transgenic cottons to safeguard the investment of private companies.

Additional Effects of Bt Cotton

The primary thrust of genetic engineering has been to reduce the use of pesticides, thus lowering the cost of production and minimizing environmental pollution. Colored cotton and improved fiber qualities, including changed thermal properties of the cotton fiber, are some other areas of research where extensive work has already been done and new genotypes are expected soon. Still the importance of Bt cotton resistant to pests will remain.

When Bt cotton was introduced, the only objective was to eliminate or at least minimize sprays against lepidopteran insects. Bt cotton has proved to be more effective against tobacco budworm *Heliothis virescens* than other bollworms. In the last two years, from the trials conducted in various countries, a number of other observations on the positive effects of Bt gene in cotton have been noted. These are

- Higher yield over normal varieties. In the USA, on the average many farmers noted approximately a 7% increase in yield. The basis for higher yield is better protection against insects.
- Usually one-day-old larvae are killed while feeding on cotton having toxin produced by the Bt gene. It has been observed that pollen grains are low in toxin, which sometimes allow the larvae to continue feeding on the flower buds.
- Lower use of insecticides has helped to control beet armyworm, *Spodoptera exigua*.
- The incidence of verticillium wilt is reduced.
- Alabama cotton leafworm *Alabama argillacea* has proved to be highly susceptible to the toxin.
- At lower levels of pest population, it may not be economical to grow Bt varieties but their use has reduced the pest population further.
- Insects will develop resistance to Bt toxin.
- It has been observed that micronaire is reduced by about 0.2 in Bt varieties, which may be due to higher boll set.

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New Developments in Ginning

All the currently available ginning machinery in the world is based on two fundamental principles of separating lint from seeds, i.e. roller ginning and saw ginning.

Roller ginning is the most primitive way of removing lint from seeds. There have been many variations and refinements in the machines working in many countries around the world but the fundamental principle of a harsh pulling of fibers from the seed coat has not changed. Fibers are gripped between rollers, blades or a roller and a blade and stretched to be separated from seeds. The space through which fibers are stretched is so narrow that it does not permit seeds passing through along with seeds. The process is comparatively slow but considered to be gentle. In saw ginning fibers are removed with the help of sharp edged metallic saws. Saw ginning is faster and more economical, but fiber characteristics are more damaged than in roller ginning.

According to a report prepared by the ICAC Secretariat for the 55th Plenary Meeting of the ICAC held in October 1996, about 15% of the world cotton production is ginned on roller gins. The system of ginning for selected countries is given below.

In Australia, there are 3 mixed roller/saw combinations, all in New South Wales. In Sudan, about 2/3 of total production is of medium staple cotton but it is still ginned on roller gins. One new saw gin was expected to start working during 1997. In Pakistan, some of the 2% of total production which is ginned on roller gins belongs to *G. arboreum*. In total, there are 8 roller gins, some of them engaged in ginning only *G. hirsutum*. In India and Iran, where *G. arboreum* and *G. herbaceum* are grown on a significant area, a large quantity of short staple cotton is ginned domestically on small roller gins. Extra fine production in India is also ginned on roller gins. In India, out of the 46,989 gins, only 460 are saw gins and all others are mostly small roller gins. In the case of USA, the number also includes roller gins.

Ginning Situation in the USA

In the USA, ginning facilities equivalent of processing over 4 million tons of lint are required. About 2-3% of the total production is ginned on 50 roller gins, mostly located in the West Region. Gins are owned by individuals, cooperatives and corporations. According to Mayfield (1997), there were 4,210 gins in the USA in 1968. While production has since increased by about 66%, the number of gins has significantly declined as small gins either quit operations or converted to bigger and more modern, automated operations. As a result, the average annual volume per gin has increased from 2,588 bales to about 14,800 bales.

System of Ginning in Some Countries

Countries	Saw Ginning (% of Total Production)	Roller Ginning	No. of Total Gins
Argentina	98	2	
Australia	98	2	39
Brazil	99	< 1	460
China (Mainland)	99	1	
Egypt		100	
India	40	60	46989
Pakistan	98	2	1140
Spain	91	9	21
Sudan		100	40
Turkey	25-30	70-75	827
Uganda		100	23
USA	98	2	1306

Cotton Ginning Statistics in the USA

Year	Production (Million Tons)	Active Gins	Volume (Bales/Gin)	Ginning Charges (US\$/Bale)
1968	2.38	4210	2588	18.64
1973	2.75	3285	3838	23.74
1979	3.11	2336	6105	39.31
1984	2.73	1860	6744	45.64
1988	3.26	1645	9109	45.14
1992	3.44	1389	11365	42.50
1993	3.42	1364	11504	43.28
1994	4.16	1306	15642	42.37
1995	3.69	1275	13280	NA
1996	3.96	1157	14818	NA

Source: Mayfield, 1997

Cost of Ginning

Ginning could be a custom operation done for growers or co-operatives by companies engaged in commercial ginning of cotton, as is the case typically in Australia and the USA. Cotton growers will bring their seedcotton to the gin and pay the fee for ginning. Thus, seed and lint both belong to the grower. He will usually trade seed to settle his account for the cost of ginning and will be responsible for selling his lint. In many other countries, particularly where landholdings are small, custom ginning is not known. Ginners will buy seedcotton directly or through middlemen and will own it. After ginning, lint and seed are property of the owner of the gin. Components of cost of production are complex and it is difficult to assess the real cost of ginning in countries where custom ginning is not available. Even in custom ginning, depreciation, fixed costs, administrative costs, etc., are difficult to calculate and compare among countries. According to the ICAC (1995), the cost of ginning in some countries is as follows:

Countries	US\$/Ton Lint
Argentina	352
Australia (NSW)	270
Brazil	170
China (Mainland)	25
Kirghizstan	146
Pakistan	300
Spain	549
Syria	176
USA	178
Zimbabwe	371

The cost of ginning given here also includes transportation costs to the ginning factory, fees for classing and grading cotton, if any, and cost of other related expenses. Compared with the total cost of producing cotton, ginning is an expensive operation in Argentina, Bolivia, Pakistan, Paraguay, Philippines and Zimbabwe. Ginning is most expensive in Spain, probably due to the subsidy paid to growers. Ginning is least expensive in China (Mainland) because it is heavily subsidized by the public sector, i.e. Bureau of Cotton and Jute of the All China Federation of Supply and Marketing Cooperatives.

New Technologies in Ginning Machines

Efforts have continuously been made to improve the fundamentals of ginning without sacrificing efficiency and preservation of quality. The approach has been to make the process as gentle as possible and to eliminate the harshness of saw gins. There may be many technologies in the offing but only two types of machines are currently being investigated on a large scale.

Cage Ginning

It is almost 15 years since the idea of cage ginning came under extensive research. The machine consists of a series of rollers mounted on the outer surface of a circular-rotating cage. With the help of an air stream, directed to the center of the cage, fibers are pushed to pass in-between the rollers. The rubber-covered nip rolls, inside the cage, press against the inner surface of the rollers and help to remove lint from seeds. The rollers are placed such that they do not allow seeds to pass through the cage. But, very much like ribs in saw gins, small and immature seeds may get through.

Practically, cage ginning is absolutely a new approach to separate fibers from seeds. The air stream is very soft compared to the forced pulling and beating action in roller and saw ginning. Air stream pressure can be adjusted depending on the type of cotton being ginned. The amount of fibers removed depends on the air pressure with which fibers are forced to pass through the rollers.

Experiments conducted for many years in the USA have shown that it is not possible to remove all lint from seeds in the case of cage ginning. Initial results showed that only 50% of fibers

were removed and the remainder, called residual ginning, was removed by normal saw ginning. The quality of fibers removed is certainly better than saw ginning, as it removes only selected fibers. Latest results indicate that there has been an improvement in the percentage of fibers removed but still some fibers are left on the seed.

Templeton Rotary Gin

The Templeton Rotary Gin can rightly be called the latest approach to change the ginning process. As reported by Thompson et al (1997), the Templeton Rotary Gin has been designed keeping in view the following two objectives:

- Produce roller gin quality long staple cotton at the speed of a saw gin.
- Simplify the technology used in cotton ginning and reduce the cost of ginning.

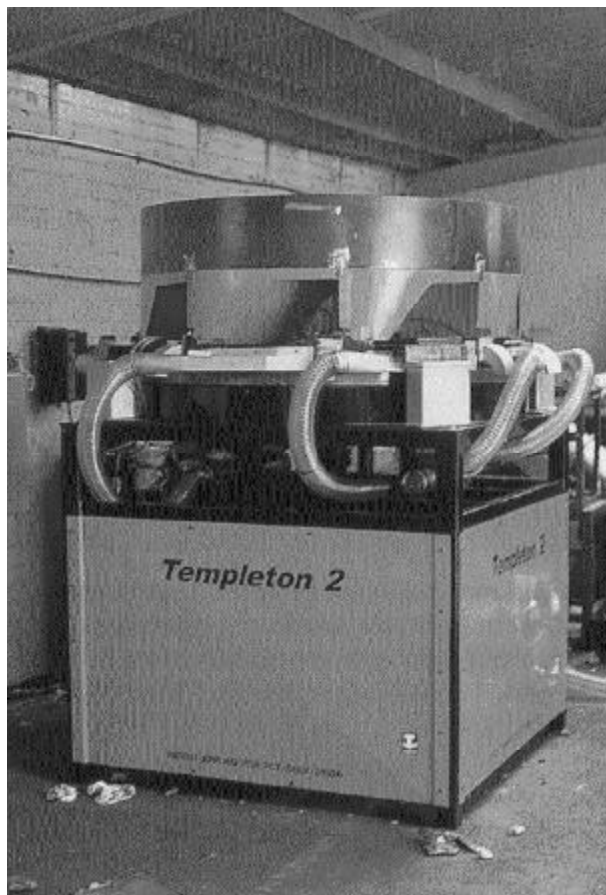
The basic design of the machine comprises a horizontal cast iron rotor or a flat disc about 1.5 meters in diameter and 15 mm in thickness. With the help of a shaft and a 15 HP motor, the disc is made to spin at 350 rpm. The rotor has eight leather segments or pouches which hold the seedcotton on the rotating disc. There are eight fixed knives radiating from the center used to remove lint from seeds. The mechanism of a leather surface combing cotton against knives is basically the same used in double roller ginning or the rotobar. In the Templeton Rotary Gin, there are eight knives thus creating eight places to gin instead of one knife and one ginning place in roller gins.

Seedcotton is fed to the Templeton gin via a feeder on the top of the gin. Seedcotton falls on the top of the rotor and leather pouches comb cotton against eight knives in one circle one after the other. Lint is sucked away with the help of an air stream while seed is thrown away from the center and collected to a second vacuum system. Most of the heavy trash also accompanies the seed.

According to Thompson et al (1997), one saw gin with a 15 ton capacity can be replaced with 30 rotobar gins for the same price or eight Templeton Rotary Gins for about half the cost of the saw gin or by 313 double roller gins operating at maximum efficiency for twice the cost of saw gins. It is also estimated that the electricity requirement is about 25% of that required by roller or saw gins operating at the same output. It is claimed that the machine can be switched to gin different qualities (long staple or extra fine category, etc.) of cotton.

Initial trials conducted in Tanzania demonstrated a need for an efficient seedcotton feeding system. A rotobar feeder has been used on the Templeton gin but it has not been able to meet the feeding needs of the machine. The high-speed rotating disc needs at least 1.3 tons/hr seedcotton. The machine is undergoing commercial scale trials at the USDA-ARS Cotton Ginning Laboratory in New Mexico, USA, and further testing at a private gin in Arizona will follow. The estimated cost for the machine is about US\$130,000.

Early data from the trials conducted in the USA during the current season indicate that Templeton 2 is capable of retaining higher fiber strength without any significant effect on length, micronaire, elongation and uniformity index. Neps/gm seemed to be higher than in the rotobar machine. Templeton Process Developments Ltd. is very optimistic about the performance of the machine and plans to license manufacturing to 5 different machine manufacturing companies, one each in China, India, Turkey, UK and USA.



Monitoring and Control of Ginning Process

Efforts have been made to measure and use color, trash and moisture measurements online to influence the ginning process. The USDA Cotton Ginning Laboratory in Stoneville, Mississippi has been working with private companies to develop the

technology. A full commercial version of gin process monitoring, called UsterR IntelliGin, will be available in the market in 1998 (Jones and Williams, 1997). Since 1994, large-scale trials have been conducted at a commercial gin, and from 1994-96 about 100,000 bales (Byler and Anthony, 1997) were ginned using the gin process monitoring and control system. Many changes have been incorporated in the last three years. The current system is capable of measuring color, grade and trash at three stages in the gin every 6 seconds. The sensing technology is similar to the one used in HVI. Online measurements of moisture content automatically optimize the drying process. Based on trash data, there is an automatic bypass of lint cleaning stages to achieve a pre-desired grade. Though off line, a micronaire test is performed at the bale press on each bale.

According to Williams and Jones (1997), utilization of a gin monitoring and control system at a commercial plant resulted in 12-kg higher lint yield and US\$ 60/ha increase in income to the grower. The cost of warehouse storage was reduced due to storage of bales based on color, grade and micronaire. Due to skipping lint-cleaning operations, ginning costs were also reduced.

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01981418 CAB Accession Number: 881108098

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Lee, L. S.; Lacey, P. E. and Goynes, W. R.

S. Reg. Res. Cent., ARS-USDA, P.O. Box 19687, New Orleans, LA 70179, USA.

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Klich, M. A.

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Mississippi Agric. and Forestry Exp. Sta., Mississippi State, MS 39762, USA.

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Dep. Biochem., Ahmadu Bello Univ., Zaria, Nigeria.

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Poswal, M. A. T. and Erinle, I. D.

Inst. Agric. Res., Ahmadu Bello Univ., Samaru, Zaria, Nigeria.

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Institut eksperimental'noi biologii rastenii, Tashkent, Uzbek SSR.

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Language: English

Document Type: Journal, 12 ref.

World Cotton Research Conference-2

Athens, Greece

September 6-12, 1998

Final Announcement and Call for Papers

The brochure has been revised to include full registration details for the Conference. All those who have pre-registered will automatically receive the revised brochure that can be obtained from the ICAC, or the Organizing Committee at the following address.

Dr. Kiratso Kosmidou-Dimitropoulou
Chairman, Organizing Committee of the WCRC-2
Hellenic Cotton Board
150, Syngrou Avenue
Athens 17671, Greece

Phone: 30-1-9220658, 9225011-15 Fax: 30-1-9249656, 9243676 Email: cotton@otenet.gr

The brochure is also available on the Internet at the following address:

<http://www.icac.org/icac/meetings/wcrc2/wcrc2.html>

Some important information from the brochure is

Conference venue: Hotel Divani Caravel
2 Vass, Alexandrou Avenue
GR 161 21, Athens, Greece
Phone: 30-1-7253725 Fax: 30-1-7253770

Registration fee: US\$300 by May 30, 1998
US\$350 by July 31, 1998
US\$400 on site
(Includes cost of welcome reception, 4 lunches, 2 dinners, coffee breaks, light show, conference material, and a copy of the proceedings.)

Hotels: Conference Venue - US\$ 140/day
Two hotels at a walking distance from the venue at US\$ 52 and US\$ 65/day

Last date for receipt of abstracts:
May 20, 1998
(No papers will be accepted for presentation after May 20, 1998)

Send abstracts to the Scientific Committee:
Dr. Urania Kechagia
Vice Chairman, Scientific Committee of the WCRC-2
Cotton and Industrial Plants Institute
57400 Sindos, Thessaloniki, Greece
Phone: 30-31-796512 Fax: 30-31-796513 Email: OK31944@compulink.gr