Cotton Breeding at Crossroads[1]

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Production

The world cotton area is estimated at 34.8 million hectares in 2004/05. According to the ICAC, 23.1 millions tons of cotton will be produced in 2004/05. The average yield is calculated at 663 kg/ha. Production and yield will be the highest ever. World cotton consumption will increase to 21.6 million tons, 1.8% higher than in 2003/04. The Cotlook A Index average for 2003/04 ended at US$1.50 per kg lint, slightly short of the long-term average for the last 30 years.

Most of the increase in the world cotton area in 2004 came from increases in China (Mainland) and the USA. Cotton was planted on 5.4 million hectares in 2004/05 in the USA, against 4.9 million hectares the previous year. Cotton area increased in China (Mainland) by 10% to 5.6 million hectares in 2004/05. The 8% increase in world area in 2004/05 over 2003/04 is forecast to result in an 11% increase in production. The increase in world cotton consumption is attributed to low world cotton prices. However, record production in 2004/05 is going to add extra cotton to world ending stocks pushing them up to 9.2 million tons, against 7.8 million tons at the end of 2003/04. Higher ending stocks will suppress international prices, and the Cotlook A index is estimated by ICAC to average at US$1.15/kg in 2004/05 and US$1.17/kg in 2005/06.

World Yields

The world average yield did not increase for nine years from 1991/92 to 1999/00. The average yield in 1991/92 was 596 kg/ha which was a record. However, the world yields for the last four seasons have ranged from 609 kg/ha in 2000/01 to 637 kg/ha in 2003/04. Favorable weather in most cotton producing countries of the world in 20004/05 will help to set a new record in yields. China (Mainland) and the USA have availed the uses of biotech cotton. The area under biotech cotton increased to over 60% in China (Mainland) and 80% in the USA. Better protection against pests continues to impact yields in both countries. Two other countries where cotton yields have shown improvements in the last few years are Brazil and Turkey. Average yields increased significantly in Brazil due to a shift in cotton area to high yielding areas of the Cerrado region, while in Turkey an expansion in irrigation has helped to harvest higher yields. Yields in most other countries have not increased in the last ten years.

Biotech Cotton

Biotech cotton was planted on 7.3 million hectares, or 21% of the world area in 2003/04. It is estimated that 30% of world cotton was produced from transgenic varieties, while 34% of the cotton traded in the world in 2003/04 came from biotech varieties. Biotech cotton area is expected to be close to eight million hectares in 2004/05, grabbing an even higher share in world cotton trade. Nine countries representing about 60% of the world total area have already commercialized biotech varieties. A number of other countries, including Brazil, Burkina Faso, Egypt and Pakistan are close to commercialization of biotech cotton. Novel genes in biotech cotton were introduced through specific varieties, and the share of such varieties is increasing at the cost of local varieties.

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Challenges

Yields Not Increasing

Cotton yields in the world did not increase from 1991/92 until 1999/00. Since 2000/01, yields increased in only a few countries, i.e. Brazil, China (Mainland) and Turkey. Cotton yields increased in India by almost 20% in 2003/04. The increase in India alone increased the world average by 14 kg/ha. Sporadic increases in yields in the USA in the last five years also increased the world average, in particular in 2001/02 and 2003/04. While agronomic practices in most countries have been optimized according to their limitations, breeders have a challenge to develop higher-yielding varieties. Conventional breeding continued as usual after 1991/92 but with no impact on yields. How breeders will contribute to boosting yields is a challenge.

Limited Availability of Germplasm

Conventional breeding can utilize only the available characteristics and combine desirable genes in one genotype for achieving an objective. The availability of good germplasm is the basis for developing new varieties. Unfortunately, there is no international germplasm bank of cotton to which most could have access. In the past, varieties have traveled frequently across countries and regions unofficially. Many countries have a limitation to utilize a specific kind of germplasm in their breeding programs, thus reducing the genetic variability in the material used in crossing and varieties grown. As biotech cotton spreads to more countries the intellectual property rights issue is requiring reconsideration by countries. Biotech products, that are currently owned by the private sector, require countries to actively pursue intellectual property rights regulations in their countries if they are interested in utilizing biotech products. Even countries where biotechnological research in the public sector is advanced are themselves interested in formulating and implementing intellectual property rights to protect their research and products. Countries and companies may be willing to share a variety but not biotech genes. Thus, in the years to come, stricter implementation of intellectual property rights will limit the spread and availability of germplasm.

Breeding Priorities Will Change

Most breeding objectives are common among countries. The common objectives are to improve yield, early maturity, better fiber quality and resistance to insect pests. Specific objectives like heat tolerance and resistance to specific pathogens and insects will continue to be a focus in many countries. Once it is acknowledged that further improvements in genetic potential through breeding are not possible, and inbuilt resistance against pests is not expected from breeders, breeding objectives will have to change. The focus could change to characteristics not considered important in the past.

Reliance on Expensive Techniques

Most research on cotton in the world, particularly in the public sector, is undertaken on breeding. China, Egypt, India and Pakistan have one of the largest teams of public sector cotton breeders in the world. Compared to the area planted to cotton in India, the public sector breeders' team may be smaller, but many private seed companies are involved in developing commercial cotton hybrids that occupy almost half of the cotton area in India. In the USA, the US Department of Agriculture is limiting its activities to germplasm development, and most area is grown to varieties developed by private companies. Future breeding work will ultimately involve biotechnology in many ways not limited to the currently used biotech products. Involvement/utilization of biotechnology will transform cotton breeding into a more expensive endeavor than it is today. Countries could face financial limitations to employ biotechnological approaches. Future breeding program could enhance the gap among countries in the level of science and technology employed to breed new varieties. Countries with better resources and access to technology will take more advantage of the technology.

Breeding will be more Science Based
Breeding is the application of genetic principles but it has been practiced more like an art of selecting the best performing genotypes in the field. Lab analysis and other data were recorded to make sure that the visual selection in the field was right. Genetic principles were employed, but far below their potential to contribute to development of superior varieties. As biotechnological approaches become advanced and popular, genetic principles will be better utilized compared to the current systems.

Variety Development Process Will be Faster
The two important stages in cotton breeding are identification of a suitable genotype and checking its performance against local standards. The third stage—approval from the government—could be crucial if many institutions and organizations are involved in breeding of varieties and government approval is necessary for commercial release of a variety. Normally it takes 10-12 years to develop a new variety through hybridization. The process is undoubtedly long but there is no alternative. New approaches involving gene insertion within, across and beyond species and; gene inactivation will make cotton breeding a much faster process compared to current practices.

New Combinations Will be Achievable
Breeders are limited by the linkage of genes in closer proximity on chromosomes and their inability to inherent independent of each other. In some cases it is impossible to break such linkages and make use of two or many characteristics in one variety. Many species of cotton cannot be crossed with each other that prohibit the use of desirable genes found in a range of wild species of cotton. Biotechnology, or the ability of researchers to isolate specific genes and insert them in desired genotypes, carries a huge potential to create non-existing combinations. How much success researchers will have in achieving such genotypes and when they will be capable to do so is debatable but all the indications are that breeding is on the way to directed breeding. Creating unique genotypes with non-available combinations will have tremendous applications in cotton breeding.

Breeding and Seed Production Will Get Closer
Development of varieties and seed production has been undertaken separately of each other. Breeders will develop varieties and hand them over to seed companies for multiplication and distribution. In many countries, breeders are responsible for production of pre-basic/foundation/nucleus seed, which is used for multiplication, and the seed thus produced is distributed to growers after proper certification. This is not the case in countries where varieties are developed and sold by private companies. Seed production systems vary a lot among countries. Certification also varies from very strict certification rules applied by an independent seed certification organization to no certification or self-certification. As the public sector breeders develop capabilities to develop varieties with novel characteristics, the systems currently followed by private companies will become popular and essential.

Biosafety Regulations
Biotechnology and bio-safety must go hand in hand. Countries that are interested in biotech products have to formulate policies to strengthen their local biotechnology sector. More and more countries are increasingly putting in place systems of regulatory oversight to cover products of modern biotechnology intended for release into the environment. These will include promoting the speedy approval of biotech varieties, and funding and infrastructure support for public-private partnership programs. All countries will ultimately use some form of biotech products provided researchers are able to produce new products that are not limited to insect and herbicide resistance. The regulations must ensure that the development, handling, transport, use, transfer and release of any living biotech products are undertaken in a manner that prevents risks to biological diversity, human health and all other areas of

concern specific to one, many and all countries. Breeders should be ready as they will be the primary party involved in safe use of biotech introductions in their countries.