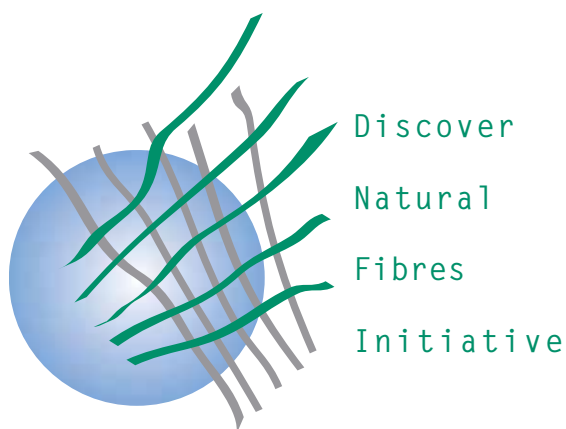




THE ICAC RECORDER

International
Cotton
Advisory
Committee



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Introduction

The first article in this edition of the *ICAC RECORDER* is from the ICAC Researcher of the Year 2016, Dr. Jack C. McCarty, Jr. of the U.S. Department of Agriculture. Dr. McCarty is the ninth winner of this award that was started in 2009. Every winner has been asked to contribute an article for the *ICAC RECORDER* about his or her vision on cotton research. The current article focuses on utilizing diversity and host plant resistance for improving cotton productivity and quality. Demands of the producers, textile industry and commercial seed industry are diversified and present a challenge for breeders to encompass them in one genotype at the same time. This is due in part to adverse genetic linkages and genetic drag, which are difficult to overcome and may require many generations of breeding and selection. A narrow genetic base further limits the resources available for use by breeders. The narrow genetic base of commercial cotton cultivars is associated with a small number of wild genotypes being used during domestication. In his paper, Dr. McCarty explains the collection and distribution of plant material in the USA by the USDA-ARS National Laboratory for Genetic Resources Preservation in Fort Collins, CO, which is not common in many countries. One approach to tap into the variability in the primitive accessions is to systematically introduce genes for day-neutrality into the accession. Dr. McCarty also discusses the utilization of host plant resistance and the development of nematode-resistant cotton cultivars utilizing QTLs and associated molecular markers. Most of Dr. McCarty's work has been in the area of germplasm enhancement for genetic diversity with specific objectives, read more in the first article.

The second article is on the activities and achievements of the International Cotton Researchers Association (ICRA). Being established in 2012, ICRA remains a comparatively young entity. ICRA is an independent organization, open to the membership of any individual researcher working substantially on cotton production research in the world. Researchers from the public and private sectors, retired

or in active service, are eligible to become members of ICRA. An Executive Committee, comprised of 15 members corresponding to geographic representation, namely four from Asia, three from Africa, two from North America, two from South America, one from Australia, and one each from ICAC and CIRAD, governs the working of ICRA. Dr. Greg Constable of Australia chaired the Executive Committee from the inception of ICRA till May 2016. At the World Cotton Research Conference-6, held in Brazil in May 2016, ICRA reconstituted the Executive Committee and elected a new Chair. Dr. Michel Fok of CIRAD is the new Chair of ICRA and also serves as Chair of the Executive Committee of ICRA. ICRA has updated the website with advanced functionalities. Now researchers can publish posts as a forum for discussion on the ICRA page. ICRA has decided to establish a Secretariat at the Pakistan Central Cotton Committee, Multan, Pakistan. The Secretariat will become operational in the near future.

The third article, entitled 'Cost of production of cotton fell in 2015/16', is a summary of the ICAC publication *Cost of Production of Raw Cotton*, released in October 2016. Thirty-one countries, which accounted for 87% of world cotton production, participated in this publication, which is updated every three years. There are certain limitations that are country-specific and must be taken into account when making inter-country comparisons but ICAC's work on cost of production is the only source of comparative data on cost of production of cotton in the world. The data show that, compared with 2012/13, the net cost of producing a kilogram of lint declined by 23% to \$1.16 in 2015/16. The decline of 34 cts/kg of lint produced is due to the lower cost of inputs and higher income from sales of seed after ginning. The data also show that the net cost per kilogram of lint produced under irrigated and rainfed conditions is \$1.05 and \$1.20 respectively. It is cheaper to produce cotton under irrigated conditions, due to higher yields, than in rainfed conditions. The 2015/16 data show that after three years the cost of fertilizers applied to

cotton remained stable at 27 cts/kg of lint produced. Fifteen years ago farmers were spending more money on insecticides and their application than on fertilizers and weeding. While the cost of weeding and fertilizers has been rising, the cost of insecticides and their application has declined. The survey shows that a cotton grower spent 12 cents on insecticides in 2015/16 to produce a kilogram of lint as compared with 16 cts/kg in 2012/13. The full report on *Cost of Production of Raw Cotton* containing detail data from 31 countries can be ordered from publications@icac.org. The 100-page report was published in October 2016.

Dictionary of Cotton

The ICAC is still selling this publication, which is a collaborative effort of ICRA and ICAC. Thirty-three

researchers from around the world have defined over 2,000 terms used in cotton production, processing and use. The publication is available at US\$50 (including shipping). Send your orders to publications@icac.org or visit the web page at: <https://www.icac.org/login?url=%2Fpubdetail.php%3Fid%3DPUB00000544>

Technical Seminar 2017

The 76th Plenary Meeting of the ICAC will be held in Tashkent, Uzbekistan in October 24-28, 2017. The topic of the Technical Seminar to be held during the 76th Plenary meeting is “Opportunities and Challenges for Technology Transfer in Cotton.” The papers presented at the Technical Seminar 2016 on the topic “Emerging Pests in Cotton and their Control”, held in Islamabad, Pakistan, will be published in the March 2017 issue of the *ICAC RECORDER*.

Cotton Improvement – Utilizing Diversity and Host Plant Resistance

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Introduction

Upland cotton, *Gossypium hirsutum* L., is an important crop that is grown in warmer climates throughout the world. Two important products are derived from the cotton plant: fiber and seed. Spinnable fibers are used by the textile industry to produce yarns and fabrics. Seeds are processed into oil, meal and hulls, which in turn are used in food items, culinary purposes, and livestock feed and other products. In the United States whole seeds are particularly important to the dairy industry as a source of high protein feed.

Estimated world cotton production exceeded 21 million metric tons in 2015/16. The top six producing countries (India, China, United States, Pakistan, Brazil, and Uzbekistan) accounted for eighty percent of the world production. Turkey, Australia, Turkmenistan, Burkina Faso, Mali, and Argentina accounted for an additional ten percent of output. The final ten percent came from sixty-five countries with production that ranged from 218 metric tons to over 196,000 metric tons. Even though production in many countries is small, cotton is important to their economies and provides a source of income for many farmers. Cotton producers worldwide are constantly under pressure to reduce input cost and improve yields in order to remain viable. Cotton is a renewable agricultural resource; however, continued research in all aspects of cotton growth and production, especially germplasm and cultivar enhancements, are essential for cotton to remain competitive and sustainable.

To meet the demand of producers and industry, cultivars with improved yield, quality, and resistance to biotic and abiotic stresses with a reduced environmental footprint must be developed. Improved fiber quality is sought by the textile industry to keep abreast with technology changes, especially changes in spinning speed. With increased speed, stronger and more uniform fiber is required to reduce yarn breakage. The seed industry would also like to see improvements in oil (quantity and quality) and protein to enhance their products. To offset higher input cost, producers want higher yield potential cultivars with enhanced resistance or tolerance to insects, diseases, nematodes and the ability to withstand environmental changes and stresses. This presents a considerable challenge to breeders with input required from multi-disciplines (entomology, pathology, physiology, agronomy and others) to achieve desired objectives and outputs.

Genetic resources must be identified and utilized to improve the desired traits. Genetic resources used for germplasm enhancement and cultivar improvement may extend from currently grown cultivars to wild relatives. With molecular biology tools and technology, useful genes can be tapped from unrelated species. Genetic diversity must not be overlooked when economic important traits are improved. Diversity can provide a buffer against abiotic stresses and environmental changes, while reducing the outbreak or spread of disease and other epidemics. Therefore, it is important to use new and unrelated sources of germplasm in cotton breeding programs to maintain a measure of genetic diversity.

Narrow Genetic Base

The narrow genetic base of modern *Gossypium hirsutum* cotton cultivars in the U.S. has been reviewed and debated over the last quarter century. The narrow genetic base of commercial cotton cultivars is associated with a small number of wild genotypes being used during domestication, the allotetraploid nature of Upland cotton, plant breeding practices, and the dominance of transgenic cultivars in recent years. Molecular marker studies have also indicated a narrow base. The narrow genetic base could impede the steady progress in the development of cultivars to meet the needs of growers and industry; however, breeders have been able to continue to make gains in yield and fiber quality traits. The degree of diversity needed to make gains in cotton is an open issue. Even though a wealth of diversity can be found in our cotton collections, commercial breeders appear reluctant to use un-adapted germplasm and wild relatives in their breeding programs. This is due in part to adverse genetic linkages and genetic drag, which are difficult to overcome and may require many generations of breeding and selection. New and innovative approaches are needed to identify and negate negative associations. The introgression of useful genetic traits into adapted germplasm has been a long-term approach by many public breeders, whereby the germplasm is then made available to industry for use in cultivar improvements. Additional information can be found in the following references: Bowman *et al.*, 1996; Bowman *et al.*, 1997; Bowman and Gutierrez, 2003; Brubaker *et al.*, 1999; Iqbal *et al.*, 2001; Kuraparthi and Bowman, 2013; Lu and Meyers, 2002; Tyagi *et al.*, 2014; and Van Esbroeck and Bowman, 1998.

U.S. Cotton Collection

The cotton collection is a valuable resource to cotton breeders and researchers in the USA and all over the world. Evidence suggests that there were no indigenous Upland cottons within the USA; therefore, parental stocks from which the cultivated varieties of Upland cotton arose were introduced from southern Mexico and Central America. Many of the early introductions were not well documented. Organized collection trips were initiated in the early 1900s, due in part to the outbreak of the boll weevil in the late nineteenth century. With the advent of collection trips the need arose for the germplasm to be assembled into collections and this was undertaken by cooperative efforts from federal, state and cotton industry scientists. Collaboration among cotton scientists led to the establishment of a regional research project (S-1) on cotton genetics in the late 1940s. A priority of this and succeeding regional projects on cotton genetics was to acquire diverse germplasm for cotton improvement. Under this project the collection, maintenance, and distribution of basic cotton stocks were organized and systematized into sub collections. The Texas Agricultural Experiment Station was assigned primary responsibility for the species, interspecific hybrids and primitive races of cotton. The Mississippi Delta

Branch Experiment was assigned primary responsibility for the principal commercial varieties, genetically marked stocks, inbred lines of Upland cotton and obsolete agricultural varieties. USDA-ARS at the University of Arizona was assigned primary responsibility for the maintenance, cataloguing, and distribution of the collection of *Gossypium barbadense*, which included Sea Island and Egyptian types, historical Pima varieties and primitive stocks.

The National Plant Germplasm System (NPGS) was established under ARS in the early 1970s. The purpose of the NPGS was to improve coordination of genetic resources and maintain existing cooperation among federal agencies, state agricultural experiment stations, and public and private sector representatives. Under the NPGS structure the three cotton sub collections were consolidated in the 1980s as a working collection at College Station, Texas, where a single full time curator would be responsible for the maintenance and distribution of germplasm. A sample of materials was provided to the National Seed Storage Laboratory, Fort Collins, Colorado, for long-term permanent and backup storage of the germplasm. Databases were established to aid curators in managing collections. Users can access collections using the online Germplasm Resources Information Network (GRIN) and its latest version GRIN-Global (www.ars-grin.gov).

The collection presently maintains about 10,000 seed accessions of the *Gossypium* spp. This material has been accumulated over time and represents over 75 countries and political jurisdictions. The material was obtained from planned explorations to various parts of the world, by donations from individual collectors, and by exchanges with other similar international collections. Currently genetically modified (GM) material is not accepted or maintained by the cotton collection.

The collection makes available and preserves the broadest possible genetic base for cotton improvement. The germplasm in the collection is freely available for distribution to all users in all countries; however, seed requests must adhere to customs and phytosanitary laws of the USA and the requesting country. Seed requests can be made online through www.ars-grin.gov or by contacting the curator at gossypium.collection@ars.usda.gov.

The collection, maintenance, evaluation, distribution and long-term storage of germplasm remains a high priority within the USDA's Agricultural Research Service (ARS). Additional information about the U.S. cotton collection can be found in Campbell *et al.*, 2010; Frelichowski and Percy, 2015; Percival, 1987; Percival and Kohel, 1990; Percy *et al.*, 2014; and Wallace *et al.*, 2009.

Registration of Plant Material

Cotton cultivars, germplasm, genetic stocks, and mapping populations can be registered with the Crop Science

Society of America (Journal of Plant Registrations), which endorses the free exchange of plant material. The purpose of registration is to provide a description of new plant material and document unique characteristics compared to available accessions. Prior to registration the plant material must be officially released by the originating organization, whether public or private. In order to be registered the plant material must be publically available for research and breeding purposes. Restricted-use releases can be registered; however, the material must be publically available upon expiration of the protection. A sample of each accession registered must be deposited by the registrant in the collection of the USDA-ARS National Laboratory for Genetic Resources Preservation in Fort Collins, CO, to ensure long-term preservation and to facilitate distribution of the plant material. Each germplasm accession is assigned a Plant Inventory (PI) number and placed in the USDA-ARS National Plant Germplasm System and will be available for distribution to researcher workers. Registration is coordinated by the Crop Registration Committee of the Crop Science Society of America in cooperation with the USDA-ARS National Plant Germplasm System. Additional information concerning registration of plant material can be found in the Journal of Plant Registrations (<https://dl.sciencesocieties.org/publications/jpr>).

Primitive Cotton Accessions

The mostly widely grown species worldwide is *Gossypium hirsutum*. This species is native to Mexico and Central America. Numerous plant explorations in these areas and the Caribbean Islands during the last century resulted in a large number of primitive or wild *Gossypium hirsutum* accessions being collected. Currently, more than 2,500 accessions are in the United States Cotton Germplasm Collection. As accessions were added to the collection they were routinely assigned a number with a 'T' prefix, which has been referred to as the Texas number. The 'T' accession number, or Texas number, is the one most frequently used by researchers to refer to the primitive accessions. A PI number is also currently assigned to all accessions in the U.S. Cotton Collection.

McCarty and Percy (2001) provided a short review of the evaluations of primitive accessions, a day-neutral conversions program and the evaluation of day-neutral converted accessions. Numerous evaluations of primitive accessions have been conducted over the years and a small sample include seed protein (Kohel *et al.*, 1985), seed oil (Kohel, 1978), seed nutritional traits (Hinze *et al.*, 2015), seed gossypol (Dilday



Figure 1. Short-day *Gossypium hirsutum* primitive accessions are growing in a tropical nursery in Mexico where they flower and can be readily crossed to Upland day-neutral germplasm.

and Shaver, 1976), boll weevil resistance (Jenkins and Parrott, 1978), *Cercospora* leaf spot and *Verticillium* wilt resistance (Jenkins and Parrott, 1978), and nematode resistance (Shepherd, 1983; Robinson and Percival, 1997; Robinson *et al.*, 2004; and Weaver *et al.*, 2007). Based on these and other studies extensive variability has been found for agronomic, morphological, and fiber traits, as well as pest resistance, in the primitive accessions. Collection and evaluation information is available for many of the accessions through the Germplasm Resource Information Network (GRIN) database and the CottonGen database. Descriptor data, such as boll shape, boll size, petal color, pollen color, leaf shape and size, plant hairs, and many other traits, for a large number of the primitive accessions can also be found in GRIN and the CottonGen database. When primitive accessions are grown in a tropical nursery by the curator of the cotton collection for seed renewal descriptor data is collected and added to the databases. Digital images are being collected for descriptors and will be added to the CottonGen database. The extensive variability in the primitive accessions is not readily available for use in breeding programs because a large proportion of the accessions require short days to initiate flowers (Figure 1). Flowering occurs too late during the growing season in temperate areas for harvestable fruit to be set. During the early 1950s more than 600 primitive accessions were grown during the summer at College Station, Texas and more than half of those accessions remained vegetative.

One approach to tap into the variability in the primitive accessions is to systematically introduce genes for day-neutrality into the accession. This can be done by crossing the primitive accession to a day-neutral donor parent in a tropical nursery where it flowers and growing the F₂ generation under long-days where segregation for day-neutrality occurs (Figure 2). Day-neutral plants can be increased and evaluated



Figure 2 (A), Short-day primitive accession (left) and commercial cultivar, (B) F_2 population of short-day primitive accession crossed to a day-neutral donor segregating for photoperiodic response and (C) day-neutral plant on the left and photoperiodic plant on the right. Photos were taken in field plots at Mississippi State, MS, in late October 2016.

for desirable traits. If the desirable traits are not found, then the day-neutral types must be backcrossed to the primitive accession to recover a greater proportion of its genome. This is an expensive long-term approach that is rarely pursued by industry. Many day-neutral lines have been developed after one cross to a day-neutral donor parent and others with one or more backcrosses to the primitive accession. Evaluation of day-neutral lines has shown lines that carry genes for improved fiber strength and fiber length as well as other desirable agronomic traits. These day-neutral lines can be directly used in breeding programs to improve cotton and also to increase genetic diversity that may affect long-term sustainability.

Host Plant Resistance

Host plant resistance is a viable option used by many breeders to enhance the plant's ability to resist or tolerate insect attacks, diseases, and nematodes. Screening techniques and methods have been developed for an array of pests. From the time cotton seed are planted in the soil until bolls are open for harvest, there are a large number of pests (soil-borne diseases, seedling, leaf and boll rot diseases, a large number of insects that can occur through the growing season, and nematodes) that can attack cotton and cause reductions in yield and fiber quality. A few transgenes have been developed to control primarily the Heliothine species, which are consistently major pests that occur over large geographic areas. Host plant resistance, as opposed to chemical pesticides, is currently the genetic option available to control many of the pests that attack cotton. Host plant resistance

traits can offer complete control for some pests; while for others only partial control is realized and supplemental pesticides are needed to prevent economic loss. Partial control in many cases reduces yield losses and the number of pesticide applications, thus benefiting growers. Host plant resistance is a long-term breeding approach, and the challenge remains to identify traits that impart resistance and incorporate them into improved germplasm. The development of molecular markers associated with resistance traits greatly enhances this process through marker-assisted selection during the breeding process. The following references provide information on insect pest of

cotton, control strategies, and selecting for plant resistance: Bourland and Myers, 2015; Jenkins and Wilson, 1996; and Leonard *et al.*, 1999.

Nematode Resistance

Utilizing host plant resistance, root-knot, *Meloidogyne incognita* (Kofoid and White) Chitwood, and reniform, *Rotylenchulus reniformis* Linford and Oliveira, nematode-resistant germplasm lines have been developed. The root-knot nematode has been recognized as a pest of cotton and other crops since the early 1900s. Screening methods for the root-knot are laborious and time-consuming, since they require growing seedlings in pots infested with the nematode in a greenhouse or growth chambers for approximately forty days. Plants are then assessed for nematode reproduction by scoring the severity of gall formation and then extracting and counting the number of eggs produced. Through long-term breeding programs, breeders have developed germplasm lines that are highly resistant to root-knot nematodes (Figure 3). Resistance is controlled by at least two major genes. Recently, molecular markers have been developed that are linked to these genes. Marker-assisted selection has greatly enhanced the transfer of this resistance to cultivars.



Figure 3. Root-knot nematode galls on susceptible (left) and resistant cotton germplasm (right).

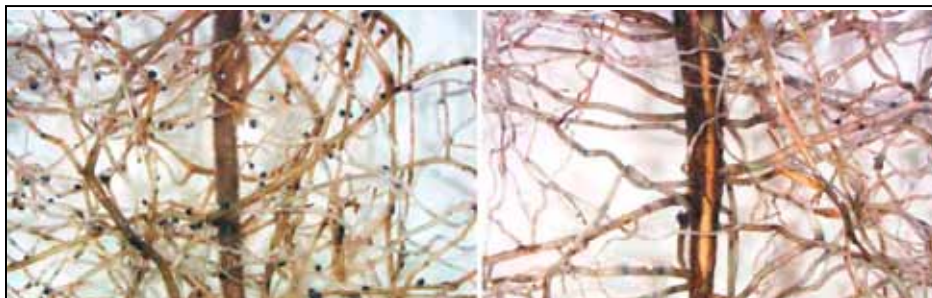


Figure 4. Roots showing eggs masses (stained blue) of reniform nematode formed on susceptible cotton lines (left) and resistant germplasm lines (right).

The reniform nematode has emerged as a significant pest of cotton in the last 25 years in the United States. Control measures are very expensive due to the limited number of appropriate chemicals and the cost of application. Alternate control methods are needed and plant resistance is a desirable option. This has accelerated the search for resistance, particularly by public research scientists. Limited sources of partial resistance have been found in *Gossypium hirsutum* germplasm accessions. A high level of resistance (almost immune) has been identified in *G. longicalyx* J. B. Hutchinson and B. J. S. Lee. The transfer of resistance from *G. longicalyx* into highly productive *G. hirsutum* germplasm has been problematic. Resistance was identified in a wild photoperiodic *G. barbadense* L. accession, GB713. This resistance has been transferred through a series of crosses and backcrosses into improved *G. hirsutum* germplasm lines (Figure 4).

Two QTLs and associated molecular markers are significantly linked to the GB713 source of resistance. These markers and those associated with root-knot nematode resistance have been used (via marker-assisted selection) to develop highly productive germplasm lines that carry resistance to both the root-knot and reniform nematodes. Industry is currently pursuing the development of nematode-resistant cultivars for growers. Both reniform and root-knot nematode resistance are host plant resistance success stories.

The following reviews and references give detail information on the damage, distribution and management of nematodes in cotton (Koenning *et al.*, 2004; Robinson, 2007; Starr *et al.*, 2007; Weaver, 2015); breeding history and development of markers associated with resistance to root-knot and reniform nematodes can be found in the

following references (Jenkins *et al.*, 2012; Gutierrez *et al.*, 2010 and Gutierrez *et al.*, 2011); transfer of reniform nematode resistance from *Gossypium longicalyx* into *Gossypium hirsutum* (Robinson *et al.*, 2007; Dighe *et al.*, 2009 and Bell *et al.*, 2014); and the transfer of reniform nematode resistance from *Gossypium barbadense* into *Gossypium hirsutum* (Bell *et al.*, 2015 and McCarty *et al.*, 2013).

Summary and Conclusion

Figure 5 illustrates the progress that can be made with a long-term breeding program that is committed to germplasm improvement for pest resistance and agronomic traits.

Cotton remains a viable commodity that is grown in many countries throughout the world. Yields and fiber quality continue to show an upward trend. Researchers must continue to develop new technologies to combat emerging weed resistance problems, as well as shifts in insect pest and disease pressure. Breeders must also continue to be innovative in developing varieties that have better water use efficiency as many parts of the world are facing water shortages as temperatures appear to be increasing. Wild germplasm must continue to be collected, preserved, freely exchanged and evaluated for useful traits. A major economic issue is to find ways to reduce the ever-increasing input cost associated with cotton production.

Most of the author's career has been spent in the area of germplasm enhancement for genetic diversity, insect resistance, nematode resistance, and agronomic research. Progress has been made; however, challenges remain.



Figure 5. Breeding progression from wild photoperiodic germplasm accessions to improved Upland germplasm.

Utilizing plant breeding and rapidly evolving molecular biology/genomics tools, these and other areas of research offer great potential as solutions to problems facing cotton farmers around the world.

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International Cotton Researchers Association: A New Term has Begun

Michel Fok, Chair, ICRA

M. Rafiq Chaudhry, ICAC (Member of the Executive Committee of ICRA)

A Successful Conclusion to the First Term

The International Cotton Researchers Association (ICRA) remains a young organization, dating back to 2012, when it was created under the initiative of ICAC. In spite of the acknowledged social and economic importance of cotton production, research on its production had not enjoyed the support of a dedicated international initiative until that time.

ICRA is an independent organization, open to the membership of any individual researcher working substantially on cotton production research in the world. Researchers from the public and private sectors, retired or in active service, are eligible to become members of ICRA. ICRA is hence distinct from the ICAC, whose members are the governments of countries with an interest in cotton. ICRA is an association established according to the laws of the United States of America, while its mode of operation is defined by rules and bylaws associated to its official establishment.

ICRA is governed by an Executive Committee composed of 15 members corresponding to a clear geographic representation, namely four from Asia, three from Africa, two from North America, two from South America, one from Australia, and two from international organizations (ICAC and CIRAD).

The first term of ICRA has been concluded, if we refer to the chairmanship of its Executive Committee as well as to the achievements reached. Dr. Greg Constable, now retired from CSIRO, Australia, chaired the Executive Committee from the inception of ICRA till May 2016. He was assisted by Dr. Dean Ethridge, as treasurer, and by Dr. M. Rafiq Chaudhry (ICAC), who addressed most of the day-to-day tasks. During this first term, major achievements worth mentioning are:

- Incorporation of ICRA in Washington, DC, USA;
- Official establishment of ICRA;
- Constitution of an Executive Committee and appointment of a chair;
- Preparation of the by-laws of the Association;
- Achievement of 501 (c) (3) tax exempt status in the USA;
- Implementation of the ICRA website, operational since early 2012; and
- Mentorship in the organization of the World Cotton Research Conference-6 in Brazil

The current update note is an appropriate opportunity to pay tribute once again to Dr. Greg Constable for having chaired

the first Executive Committee of ICRA. All those responsible for promoting a new organization know how demanding this is in terms of time and energy.

World Cotton Research Conference-6

The World Cotton Research Conference-6 (WCRC-6) was held in conjunction with the 2016 Biennial Conference of the International Cotton Genome Initiative in the city of Goiânia, Brazil, from May 2-6, 2016. It was a great opportunity for researchers to present their research, expand and strengthen their networking and learn about the most important research work being conducted in the world. The Cotton Growers Association of Goiás-AGOPA (Associação Goiana dos Produtores de Algodão-AGOPA) served as the primary host, while the cotton research program 'EMBRAPA Cotton' of the Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária-EMBRAPA) played a crucial role in designing and executing the technical program during the Conference. 471 researchers from 40 countries and five international organizations attended the Conference.

The ICAC Secretariat coordinated international sponsorships and worked with the Organizing Committee, Program Committee, International Cotton Researchers Association and leadership of the International Cotton Genome Initiative (ICGI) to shape a successful conference and to ensure a clear understanding among the various organizers of the WCRC-6. For the first time the Conference was held under the auspices of the International Cotton Researchers Association (ICRA), whose chairman Dr. Greg Constable headed the International Committee that selected keynote and plenary speakers. The International Committee advised the Organizing Committee and Program Committee as needed. The roles of various institutions were well-defined, but the active involvement of the ICAC as a neutral and umbrella organization and to provide guidance based on experiences with the previous world cotton research conferences was still required. The program included two keynote speakers and eight plenary speakers with 28 specialized concurrent sessions.

The ICAC has sponsored the World Cotton Research Conferences since their inception in the early 1990s. The Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), of France, has sponsored the conferences since 1998 and continued its support for the WCRC-6. The Food and Agriculture Organization of the United Nations (FAO) has also provided support to World Cotton Research Conferences, including the WCRC-6. For the first time, the Centre for Agriculture and

Biosciences International (CABI) also provided sponsorship to the Conference. Support from the local private sector was a tremendous asset in the success of the WCRC-6, as was the case in previous Conferences. For the first time, the international sponsorship was channeled through the International Cotton Researchers Association (ICRA). Sponsorships were pooled and formally advertised through the ICAC and ICRA websites and mailing lists. In total, 36 researchers received four kinds of sponsorships directly from ICRA. The Organizing Committee also decided to sponsor 10 researchers for registration, accommodation and technical tour. These 10 names were also taken from the ICRA applicants. Eighty-two researchers applied to ICRA for sponsorship, of which 46 were sponsored.

The book of abstracts will soon be made available on the WCRC-6 web page. The ICAC has already published abstracts of the keynote and plenary presentations in English, French and Spanish languages in the *ICAC RECORDER*, Vol XXXIV, No. 2, June 2016. The report also includes a summary of the papers presented in the ICGI sessions. Copies can be requested free of charge from the ICAC at publications@icac.org.

The World Cotton Research Conference-7 will be held in Izmir, Turkey, in May/June 2020.

WCRC-6 List of Participants by Country			
Country	No. of Participants	Country	No. of Participants
Argentina	8	Myanmar	2
Australia	24	Mozambique	5
Bangladesh	2	Netherlands	1
Benin	1	Nigeria	3
Brazil	212	Pakistan	13
Burkina Faso	1	Portugal	5
Chad	1	Peru	4
China	23	Poland	2
Colombia	4	South Africa	3
Ecuador	1	Spain	1
Egypt	4	Syria	1
Ethiopia	1	Sudan	6
France	1	Tanzania	2
Germany	1	Togo	1
India	37	Turkey	11
Indonesia	2	Uganda	3
Iran	6	USA	58
Israel	1	Uzbekistan	2
Kenya	3	Vietnam	1
Mali	3	Zambia	2
International organizations:			
CABI	= 1		
CIRAD	= 2		
Food and Agriculture Organization	= 2		
International Atomic Energy Agency	= 2		
International Cotton Advisory Committee	= 2		
Total	= 471		

ICRA Finances

Dr. Dean Ethridge, Managing Director of the Fiber and Biopolymer Research Institute, Lubbock, Texas, USA, who is member of the Executive Committee of ICRA, also serves

as the Treasurer of ICRA. The Treasurer's report presented to the 5th Meeting of the Executive Committee of ICRA, held in Islamabad, Pakistan, on October 30, 2016, detailed expenses and income. As of October 2016 ICRA has a balance of \$225,625 in its account with no pending payments. The EC is currently finalizing investing some money in Certificates of Deposit until it is needed for the WCRC-7 in Turkey.

ICRA has been operating without any direct funding support so far, the above-mentioned financial balance having mainly resulted from savings derived from the organization of world cotton research conferences. The sound management of limited funds has implied particular caution in commitments to expenditures. Specific sponsorships, from national, regional or international organizations, are very much desired in order to enable ICRA to perform its role of promoting cotton research worldwide by launching and supporting training sessions, if not collaborative activities between researchers from various countries. ICRA operates without any administrative costs and can ensure that all sponsorship funds will be fully dedicated to collaborative actions among cotton researchers.

Expenses report on WCRC-6

The total cost of the World Cotton Research Conference-6 was US\$450,491. Major details are shown on the following table..

Expense Report on the WCRC-6	
Item	Cost in US\$
1. Infrastructure	
a. Convention Center, main hall and concurrent session rooms	46,114
b. Decoration and ceremonial	10,063
c. Buffet (lunches)	57,424
d. Simultaneous translation in Portuguese	7,531
e. Infrastructure for reception desk, restaurant, lecture rooms, auditorium, cyber café, and booths	11,058
f. Audiovisual equipment	25,814
g. Bus transportation	19,143
h. Prints (brochures; event's schedule folders, and abstract folders)	9,609
i. Participant package (backpack; pen; name tag; notepad)	9,776
j. Service rendered by company in the organization of the event	27,143
k. Official event website and internet	2,378
l. Receptionists services, security and surveillance, maintenance, and general cleaning	17,499
2. Sponsorship of Plenary and other speakers	
a. Flight ticket	20,586
b. Hotel reservation	6,727
3. Dinner and welcome reception	
a. Venue	2,287
b. Buffet	16,949
c. Rental furniture and decoration	6,858
d. Musical performance	4,565
4. Fee for holding the WCRC-6	
a. ICRA fee	80,000
b. Taxes and shipping fees/monetary exchange contract	10,897
5. Other expenses	58,070
Total:	450,491

A New Term With Some Administrative Changes

ICRA is embarking on a new term with the partial renewal of its Executive Committee, as a result of the voluntary withdrawal of five members, notably due to retirement, as in the case of Dr. Constable. Five new members have been selected in compliance with the above-mentioned rule of geographic representation. At its 4th Meeting, held in Brazil during the WCRC-6, the Executive Committee elected Dr. Michel Fok, from CIRAD (France), to chair the Executive Committee until the WCRC-7 in 2020.

The new term is also characterized by two significant administrative developments. It was felt necessary to select a Vice-Chair to assist the Chairman; Dr. Mohamed Negm, of Egypt, was elected to this position. It was also found relevant to establish a Secretariat as stipulated in the Association's Rules & Bylaws, whose operation should enable ICRA to be active at the desired level.

Establishment of ICRA Secretariat

During the 4th Meeting of the Executive Committee, a decision was taken to establish a Secretariat office of the organization. The revenue received by the ICRA is currently insufficient to support a paid Secretariat staff. Therefore, the Executive Committee resolved to request an institution to voluntarily provide a physical location and staff support, thereby becoming a transitional ICRA Secretariat on volunteer basis. Rafiq Chaudhry was assigned of the task of soliciting a volunteer organization. No formal procedures and criteria for evaluation of applicants were decided. The initial emphasis was on filling the position of Secretary and Assistant Secretary of ICRA, which slowly evolved to a 'Secretariat' instead.

Applications Invited

Applications via the e-mailing list of ICRA were invited on May 23, 2016. Regarding the duties of a Secretary or Assistant Secretary, the bylaws of ICRA state: *Except as otherwise provided in these Bylaws or as directed by the Executive Committee, the Secretary shall attend all meetings of the Executive Committee; he/she shall record the minutes of all proceedings in books to be kept for that purpose; he/she shall give notice of all meetings and special meetings of the Executive Committee; and shall keep in safe custody the seal of the Association, and when authorized by the Executive Committee, he/she shall affix the same to any corporate instrument. The Secretary shall have such other powers as the Executive Committee, or the Chairman of the Executive Committee shall assign to him/her.* Applicants were also informed that ICRA activities are expanding and, if time and resources permit, the Secretariat may need to: a) ensure that the web site is populated with current information; b) ensure that the roster of members is current and accurate; c) compile a database of cotton research activities; d) arrange conference calls and webinars among researchers; and e)

provide assistance to the arrangement of exchange visits among researchers.

Additional details were provided following the announcement so as to receive applications in a uniform order. The applicant institution was required to designate one or more permanent staff members as contact persons and to discharge the tasks delegated by the Executive Committee of the ICRA. As announced, a memorandum of understanding would be executed and signed by the Chairman of the Executive Committee and the appropriate authority at the volunteer institution. The response of volunteer institutions may stipulate limits on the facilities it will provide and the tasks it will perform. These limitations would become part of the memorandum of understanding should the offer be accepted by the Executive Committee.

Interested institutions were advised to submit a short proposal no later than June 15, 2016. Any clarifications could be pursued quickly, with the objective of finalizing the memorandum of understanding as soon as possible.

Evaluation of Applications

The following six institutions applied to host the ICRA Secretariat:

1. National Agricultural Technology Institute (INTA), Experiment Station, Sáenz Peña, Argentina
2. Punjab Agricultural University, Ludhiana, India
3. University of Agricultural Sciences, Agricultural Research Station, Dharwad, India
4. Kenya Agricultural and Livestock Research Organization, Biotechnology Institute, Nairobi, Kenya
5. Ahmadu Bello University, Institute for Agricultural Research, Zaria, Nigeria
6. Pakistan Central Cotton Committee, Multan, Pakistan

The six applications were sent to the Executive Committee for evaluation/scoring on 29 selected items. Rafiq Chaudhry compiled the scores and shared them with the Chair and Treasurer. Open individual scoring was not shared with all members of the EC. Scoring for each institution was shared with all EC members without disclosing the identity of EC member (Names of the members were coded). The EC had agreed in advance that the two highest scoring candidates would be taken to the next stage of evaluation. The two highest scoring institutions were from India and Pakistan and scored 67% and 77% points, respectively, based on the average of 29 questions. The institutions are

1. Pakistan Central Cotton Committee, Multan, Pakistan
2. University of Agricultural Sciences, Agricultural Research Station, Dharwad, India

The issue went back to the EC to explore further evaluation of the two applications. Michel Fok prepared a list of 29 new questions for a second round of questions from the two

finalists. After comments and observations, nineteen questions were agreed on by the EC. The second questionnaire was sent out on August 31, 2016. Based on the evaluation by 15 EC members of the replies to the 19 questions and a maximum of five scores for each response, the UAS, India, and the PCCC, Pakistan, were adjudged to have scored 85% and 83% of the total possible score respectively.

Decision

The Secretariat issue was discussed during the 5th Meeting of the Executive Committee of ICRA, which was held in Islamabad, Pakistan, on October 30, 2016. The Committee interviewed the two applicants separately. Each institution was allocated 20 minutes to present its case as to why they consider themselves a suitable candidate to host the ICAC Secretariat. The presentations were followed by questions from the members present. Similar questions were asked of both applicants, such as: What was the most important purpose of ICRA? What would be the most important activity of the ICRA Secretariat? Would the Secretary and Assistant Secretary receive remuneration from the institution? How long the institution was willing to commit to serve as the ICRA Secretariat?

The EC meeting discussed the presentations and answers to the questions without the applicants. The EC members present in the meeting unanimously decided to recommend to the full Executive Committee that the Pakistan Central Cotton Committee be offered the opportunity to host the ICRA Secretariat.

The offer has been made to the Pakistan Central Cotton Committee to host the ICRA Secretariat and provide contact details of the Secretary and Assistant Secretary of ICRA. Michel Fok and Rafiq Chaudhry will work with the PCCC to initiate Secretariat work. Continuous updating of the web page information and making it more interactive will be a permanent task of the Secretariat. The Secretariat will propose new initiatives to the Executive Committee before formally materializing them, as well as working closely with the Executive Committee under instructions from the Chair of ICRA.

Initiation of a Process of Interaction with Members

The objectives of ICRA remained unchanged so far. In short, ICRA aims to:

- Promote and strengthen networking among cotton researchers, related to information dissemination, sharing of problems hampering cotton production and management of a database on cotton research activities;
- Serve as an international voice on cotton research, with the concern of training the next generation of cotton researchers and specialists;
- Enhance the competitiveness of cotton through the

dissemination of cotton research findings and outputs;

- Advise host countries in managing and running the WCRC; and
- Foster interest in ICRA and its objectives amongst cotton researchers.

The new Executive Committee puts greater emphasis on ICRA operating for cotton researchers and by cotton researchers. In this regard, it favors an approach of consulting members to provide guidance to ICRA actions. The availability of cheap and convenient online survey tools helps to make this approach practical.

A first survey was implemented on the ICRA website in May 2016 to capture the views of members. The main points raised by the 142 members who responded were:

- Respondents were in majority male researchers, but researchers with short experience were less well represented;
- One third of the respondents affirmed their willingness to assist the ICRA Executive Committee, occasionally or otherwise, in making ICRA active at the desired level;
- The ICRA website was visited but not very frequently;
- The ICRA logo was well appreciated;
- A forum function was found valuable, particularly if adapted to members' desires;
- Generational transfer was considered important to very important, although few examples of topics were provided;
- Most responding members considered it valuable that ICRA helps to identify who's who in cotton research, notably on members' careers and on their research projects somewhat comprehensively;
- They also considered valuable for ICRA to set up a stock exchange of offers and demands for collaborative activities.

Website with Advanced Functionalities

ICRA is now visible through a new version of its website whose structure is better suited to promote interaction between ICRA members, in line with the vision of an Association for and by its members.

The new website has been implemented within two months of canvassing the opinions of ICRA members through the above-mentioned survey. It can be claimed that ICRA has a website of advanced functionalities that are seldom encountered in other researchers' associations:

- The review of posts before their publication has been made simpler and more centralized (by a handful of ICRA members endowed with a website administrator

role). Posts are destined to inform about cotton research worldwide and tagged according to the type of scientific discipline, but not exclusively;

- Any post published becomes a topic of forum discussion, so that it can be commented and appreciated;
- A forum function, called 'Gossyforum', has been incorporated. It has more features and is more user-friendly than the existing one. Forum discussion around topics could effectively replace email exchanges for as many groups of ICRA members as possible, regardless of group size. ICRA members can decide on which discussions to follow and also give their views on the topics discussed, like in social networks;
- A Wiki tool, called Gossypedia, has been set up. It is destined for collaborative editing on topics worthy of generational transfers. Validation before publication is compulsory so as to verify the scientific background of proposed texts.
- The function of members' profiles, called GossyP (for Gossypium Profiles), has been improved, so as to provide information on each member's educational background, career, publications and cotton research projects. The GossyP function is articulated with the function at registration, which has been made as simple as possible. New members will be invited to click on the GossyP link to provide further information, which can be amended at any time.
- A new function has been added to inform about job vacancies but extended to various types of jobs, including demands and offers of training.

- A payment function has been inserted to enable donations, notably from members, and later on, if decided, membership payments.

ICRA is now endowed of an internet tool adapted to its objective of serving the interaction between cotton researchers worldwide. Researchers must now take advantage of this tool.

ICRA Website as a Platform of Online Proceedings of Cotton Research Conferences

During its 5th Meeting, the Executive Committee of ICRA decided to make available the online proceedings of all World Cotton Research Conferences that have been organized so far, including the first one, which took place in 1994, more than twenty years ago. The structure of the ICRA website is suitable to host online proceedings: each communication will be introduced through a specific post, associated to uploaded files corresponding to a full text and/or slideshow, while the post will become automatically a topic for discussion.

One of the first tasks of the new ICRA Secretariat will be to make available the online proceedings of previous World Cotton Research Conferences on the ICRA web page with papers formatted in a uniform manner.

Once the online proceedings of World Cotton Research Conferences are available, the Executive Committee of ICRA will examine the relevance and feasibility of proposing to cotton researchers to host the proceedings of the seminars or conferences they organize, hence saving them the task of setting up specific websites and assuring them of a large audience.

Cost of Production of Cotton Fell in 2015/16

The Technical Information Section undertakes a survey of the cost of production of cotton every three years. The current report includes data for the year 2015/16. Thirty-one countries, which account for 87% of the world cotton area, participated in this survey. Eleven countries provided data for more than one region, thus raising the total number of entries to 53. The questionnaire used to gather the cost of production data has remained unchanged since 1991. The only addition to the questionnaire has been the 'technology fee', which is related to insect-resistant and herbicide-tolerant cotton in countries that have commercialized biotech varieties. The unchanged questionnaire allows for comparison of data over time. All inputs and agronomic operations are covered in the questionnaire, and only a few entries from some countries are classified as 'other'. However, one of the main shortcomings for comparing the net cost of production per kilogram of cotton is the lack of complete data for some countries.

Differences in production systems, failure to take into account opportunity costs for operations done by farmers themselves, and government support on costs of inputs continue to be a problem in making accurate comparisons. Many countries either have minimum economic and fixed costs, or simply do not estimate these costs, while in some countries economic and fixed costs form a major portion of the total expenses incurred to grow cotton. There are certain limitations that are country-specific and must be considered when making inter-country comparisons.

In Argentina, China, Colombia, India, Pakistan, Sudan and the USA, the technology fee for insect resistance and herbicide tolerance (where applicable) is included in the price of the planting seed. Australia, Brazil, Burkina Faso, Paraguay and South Africa have reported the technology fee separately. In Argentina, the cost of insect control is the cost of four sprays against the boll weevil, as well as pheromone traps for the same insect. Some chemicals are also applied during pre-soaking irrigation to eliminate regrowth and weeds. Plowing before sowing is usually performed by chiseling in Santiago del Estero and by disk harrow, cultivator and toothed-harrow in Chaco province. In Indonesia, the cost of production data refers to mixed cropping with cash crops. The average yield in Pakistan in 2015/16 was only 528 kg/ha, as compared to a normal yield level of over 700 kg/ha. Similarly, there are other issues that are specific to certain countries.

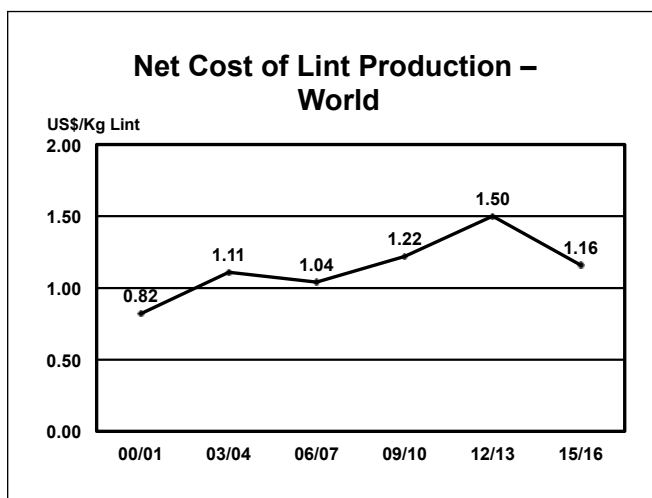
The U.S. data is for five regions i.e. Heartland, Mississippi Portal, Fruitful Rim, Prairie Gateway and Southern Seaboard. These regions are consistent with delineation across all of commodities and attempts to classify farms into homogeneous resource and farm-type regions. Data were taken from <http://www.ers.usda.gov/data-products/commodity-costs-and-returns.aspx>. The USDA's Economic Research Service compiled this report using data from the Agricultural Resource Management Survey. The data categorized as insecticides

and weed control include all chemicals, such as herbicides, insecticides, growth regulators and defoliant. The cost of picking is not calculated separately, but covered under various categories including fuel, lube and depreciation.

Net Cost of Production of Lint - World Average

The data for the 2015/16 season from thirty-one countries, which accounted for 87% of the world cotton area in the year, showed that the net cost of production of cotton lint declined in 2015/16 after many years of continuous increases. Compared with 2012/13, the net cost of producing a kilogram of lint, which does not include land rent and the value of commercial seed after ginning, declined by 23% to \$1.16 in 2015/16. The decline of 34 cts/kg of lint produced is due to the two main reasons as below.

1. The cost of inputs per kilogram of lint produced did not increase for any of the inputs in 2015/16. The costs of insect control, weed control, ginning and harvesting declined in 2015/16. The cost of fertilizer per kilogram of lint produced remained at the same level as in 2012/13.
2. For the purpose of calculating the net cost of production per kilogram of lint, the income from selling commercial seed after ginning was deducted from the gross cost. The value of commercial seed after ginning increased by over 50% in 2015/16 in comparison with 2012/13.



Irrigated vs Rainfed Cotton

The average net cost of production per hectare in 2015/16 was \$1,006 under irrigated conditions and \$776 under rainfed conditions—both lower than in 2012/13. Lint yield in 2015/16 averaged 957 kg/ha under irrigated conditions and 647 kg/ha under rainfed conditions. The 31 countries that participated in the 2015/16 cost of production survey planted 60% of their area under irrigated conditions and 40% under rainfed

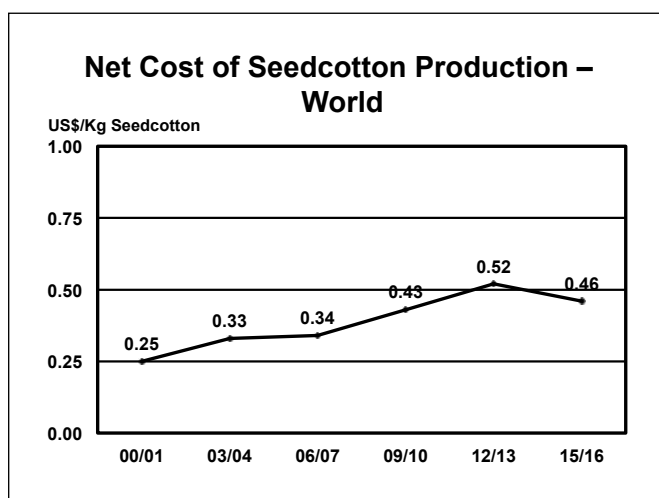
conditions, almost the same as ratio as was observed in the participating countries in 2012/13. It is cheaper to produce cotton under irrigated conditions, due to higher yields, than in rainfed conditions. The cost per kilogram of lint produced under irrigated and rainfed conditions is \$1.05 and \$1.20 respectively. Sixty-nine percent of world production in 2015/16 came from irrigated conditions. On average only 7 US cents were spent on irrigation to produce a kilogram of lint in 2015/16.

Biotech vs. Non Biotech Cotton

Among the countries that have commercialized biotech cotton, the majority of the area under cotton is planted to biotech varieties/hybrids. The data show that biotech cotton lowered the net cost of production. The net cost of production in countries that allow the use of biotechnology was \$1.05/kg of lint. The net cost of production in non-biotech countries averaged \$1.29/kg. The average yields in the two groups were almost equal. However, higher spending in producing a hectare of conventional cotton resulted in a higher net cost per kilogram of lint. In the 31 countries that participated in the survey, biotech varieties accounted for 77% of the area and 91% of production.

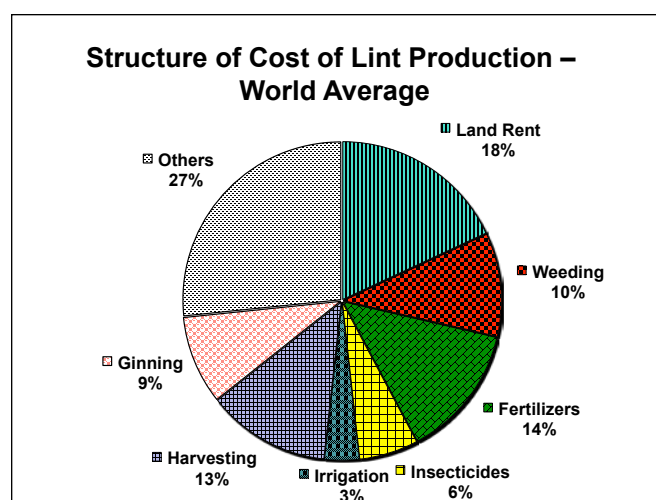
Net Cost of Production of Seedcotton - World Average

The average cost of production of seedcotton was \$0.43/kg in 2009/10 and \$0.52/kg in 2012/13 and had been on increase since at least 2000/01. The cost of production of a kilogram of seedcotton doubled in 15 years, from \$0.25 in 2000/01 to \$0.52 in 2012/13. For the first time this trend has reversed with a net cost of production of seedcotton at \$0.46/kg in 2015/16. These seedcotton cost calculations are based on the assumption that farmers are self-cultivators and do not pay rent for land use. The lower cost of production of seedcotton is quite in line with the lower net cost of production of lint/kg. The net cost of production of lint declined from \$1.50/kg in 2012/13 to \$1.16/kg in 2015/16.



Structure of Cost of Production

Considering the gross cost of lint production, 18% (36 cents) were spent on renting land to produce a kilogram of lint. The most expensive input came out to be fertilizers, which accounted for 14% of the gross cost (27 cts/kg lint produced), followed by 13% (24 cts/kg) for harvesting/picking and 10% (21 cts/kg) for weeding. The cost of insect control declined over the last decade and stood at only 6% of the total production cost in 2015/16. Irrigation accounted for only 3% of costs. As with all other inputs and operations, the reported cost of irrigation represents the average cost of irrigation per kilogram of lint produced in all participating countries. In some cases, the 10 cts/kg lint spent by producers on planting seed also includes the technology fee for biotech trait(s). The 'others' category includes economic costs and fixed costs, in addition to the operations and inputs not mentioned in the pie chart.

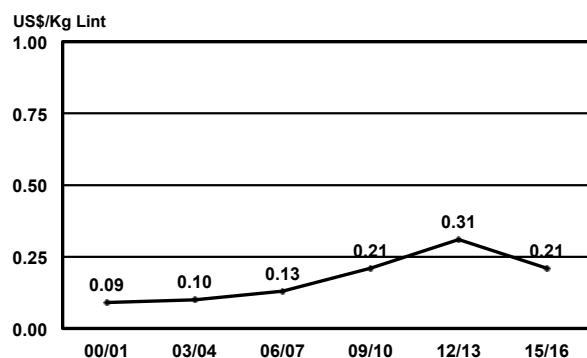


Cost of Operations and Inputs

Weed Control

Weeds can be removed culturally, manually, mechanically or chemically, and it is very important that they be removed in a timely fashion. The main reason for the increase in the cost of production in 2012/13 was an increase in the cost of weeding. The use of herbicides is gaining popularity in many countries, while the costs of labor and cultivation are increasing. The use of herbicides has environmental consequences, but herbicides provide perfect control for a longer time if applied properly and in correct doses. Herbicides can be used before or after sowing, depending on the field situation and the probability of eliminating weeds. Herbicide products have been in use for much longer than insecticides because insecticides have changed frequently in response to the development of resistance and improved control methods. In contrast, the weed complex has not changed significantly in most countries. One of the first herbicides used in the world, 2,4-D, remains one of the most commonly used herbicides. Herbicide-tolerant

Cost of Weeding

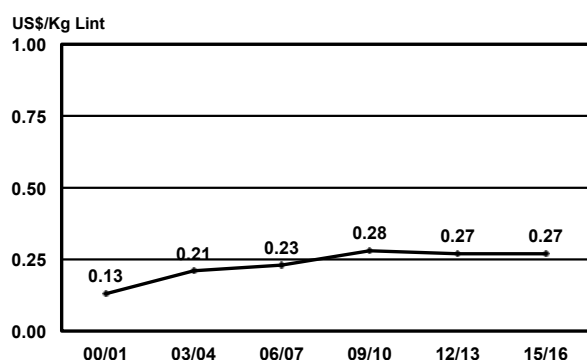


cotton was commercialized in 1995/96, one year before insect-resistant cotton was released. The current report shows that concerns about weed control are rising. In 2000/01, 9 cents were spent per kilogram of lint produced, compared to 21 cts/kg of lint in 2009/10, and 31 cts/kg of lint in 2012/13. Weed control costs declined to the level of 2009/10 i.e. 21 cts/kg lint produced, most probably due to increased adoption of chemical weed control.

Fertilizers

The cost of fertilizers and their application more than doubled in the nine years from 2000/01 to 2009/10. On average, a cotton grower spent 13 cents on fertilizer to produce a kilogram of cotton lint in 2000/01, compared to 28 cts/kg in 2009/10 and 27 cts/kg in 2012/13. The 2015/16 data indicate that farmers are finding ways to best utilize the nutrients that have already been applied, since the cost of fertilizers remained stable at 27 cts/kg lint produced. Nitrogen use has been optimized and now there is a need to lower the quantity of fertilizers applied, particularly nitrogen fertilizers. Efforts have to be made to enhance nitrogen use efficiency.

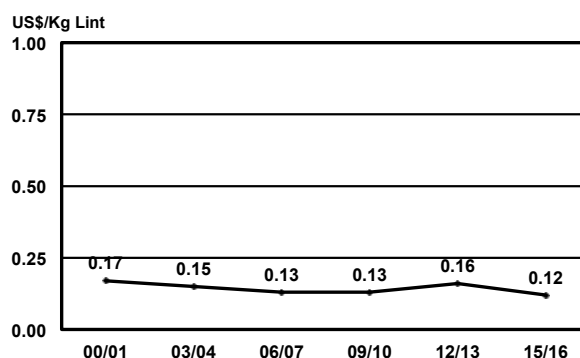
Cost of Fertilizer



Insecticide/Insect Control

Among the five major components of the cost of production of lint, insecticide costs are the least important and represented only 6% of the total cost in 2015/16. Producers spent more money on fertilizers, weeding, picking and ginning to produce lint. Fifteen years ago a farmer was spending more money on insecticides and their application than on fertilizers and weeding. In 2000/01, on average farmers spent 17 cents on insecticides to produce a kilogram of lint, compared to 9 cts/kg on weeding and 13 cts/kg on fertilizers. While the cost of weeding and fertilizers has been rising, the cost of insecticides and their application has declined. Based on the average of the 31 countries that participated in the current survey, a cotton grower spent 12 cents on insecticides in 2015/16 to produce a kilogram of lint as compared with 16 cts/kg in 2012/13. Many factors are responsible for the decline in insect control costs. The adoption of insect-resistant biotech cotton undoubtedly lowered the need for insecticide use. The biotech fee in some cases is included in the seed cost rather than being counted as insect control costs. Growers are reluctant to use insecticides because of their negative experiences in the past. Producers suffered because of a heavy reliance on insecticide use, and the negative consequences of insecticide use are better understood now than when these products were introduced and broadly encouraged.

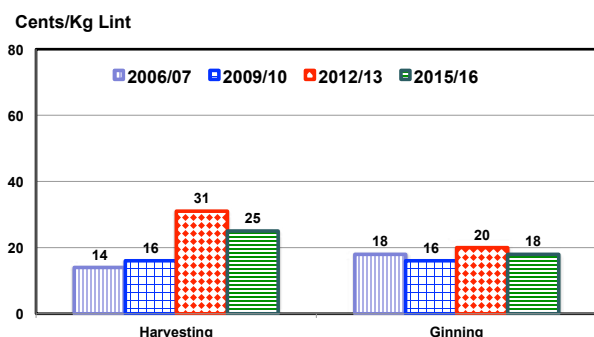
Cost of Insecticides



Harvesting and Ginning

The cost of picking includes bagging and stick cutting/slashing. The cost of picking/harvesting has shown high variation from survey to survey, probably due to labor costs and shifting/switching from manual to machine picking and vice versa. In 2015/16, the average cost of picking/harvesting was 25 cts/kg of lint produced. The data for the last four surveys showed that cost of ginning has fluctuated in a range between 16 and 20 cts/kg lint, with a middle value in 2015/16. The opportunity cost for ginning from most countries that do not have custom ginning is included in the data for calculating the average cost.

Cost of Harvesting and Ginning – World



Cost of Production in Seven Major Countries

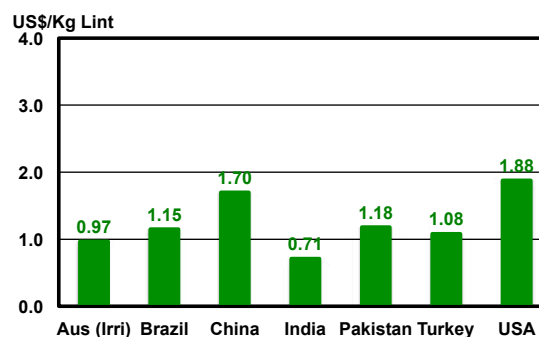
None of the Central Asian countries participated in the survey. The data for the seven other major countries show that it is most expensive to produce cotton in the USA, followed by China. India is the least expensive country in which to produce cotton. The cost of insect control in Brazil is not only the highest in the world, but also many times the cost of insect control in the seven major countries compared. Fertilizer costs are highest in China, particularly in the Xinjiang region. In China, cotton is over-fertilized and topping is required to control excessive vegetative growth. Among the seven major producing countries included in the survey, weeding is most expensive in China, due to manual weeding in the Yellow and Yangtze River Valleys.

Seed Value after Ginning

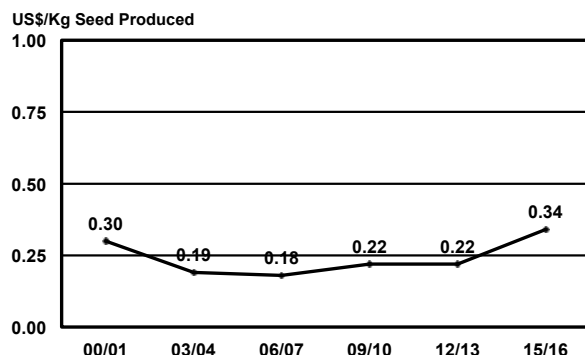
In some countries, farmers pay for ginning and own the lint and seed, a system that is known as custom ginning. Even if custom ginning is not popular in a country, a farmer selling seedcotton is receiving an implicit price for lint and seed, although these prices are not separately identified. The value of seed after ginning is substantial in many countries and was deducted from the total cost in order to determine the net cost per kilogram of lint reported here. Thus, the value of seed has a significant impact on the net cost of production.

Among the surveys conducted in the last 15 years (every three years), the highest value of seed was 30 cents in 2000/01. The value of seed averaged 22 cts/kg in 2012/13, increasing to 34 cts/kg in 2015/16. The seed value proved to be a significant factor in lowering the net cost of production of lint in 2015/16.

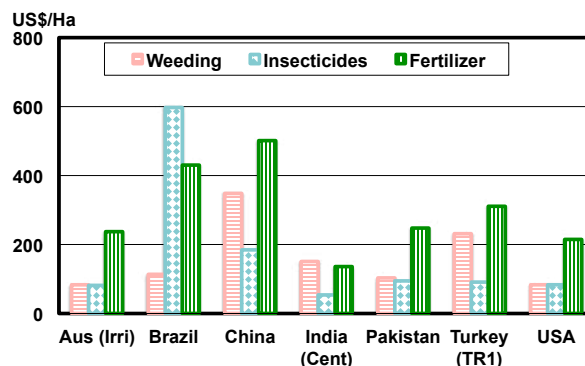
Cost of Production in 7 Major Countries



Seed Value After Ginning



Input Costs in 7 Major Countries

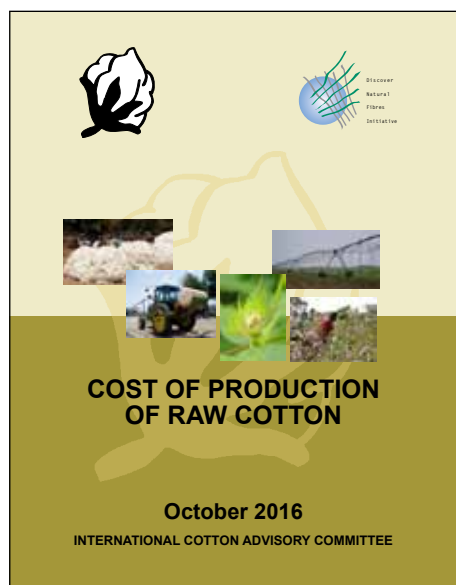


Note: The full report on *Cost of Production of Raw Cotton*, which was published in October 2016, containing detail data from 31 countries, can be ordered on <https://www.icac.org/login?url=%2Fpubdetail.php%3Fid%3DPUB0000048>

COST OF PRODUCTION OF RAW COTTON

THE 2016 EDITION WILL BE AVAILABLE SOON

Cost of Production declines in 2015/16



The report includes data by country for the 2015/16 season. Many countries are reporting data by region or type of cotton. This study is the only source of comparative information on the cost of cotton production in the world.

The costs of all field operations starting from pre-sowing to harvesting and ginning and economic and fixed costs have been determined and computed to determine the cost of production of cotton per hectare and per kilogram.

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