Proceedings and Recommendations of the
13th ICAC-Network Meeting on Cotton for Mediterranean and Middle East Regions

K. R. Kranthi
International Cotton Advisory Committee, Washington DC.

The 13th ICAC-Network Meeting on Cotton for Mediterranean and Middle East Regions was held at Luxor, Egypt on 2-6 February 2018. The International Cotton Advisory Committee (ICAC) and the Cotton Research Institute, Egypt jointly organized the meeting.

BACKGROUND: Starting from the first 'Network meeting on cotton for the Mediterranean and Middle East regions' in 1984, Greece hosted the meetings on five occasions in 1984 (1st), 1992 (4th), 2001 (8th), 2004 (9th) and 2008 (10th). The 2nd, 3rd and 5th meetings were held in France in 1986, 1988 and 1996 respectively. Italy held the 6th meeting in 1998. Turkey conducted the 7th and 11th network meetings in 2000 and 2012. The 12th and 13th meetings were hosted by the Cotton Research institute Egypt in Sharm-El-Sheikh in 2015 and Luxor in 2018.

INAUGURAL SESSION: His Excellency E. Mohamed Badr, Governor of Luxor inaugurated the meeting in the presence of Mr. Kai Hughes, Executive Director, ICAC; Dr. Ahmed Moustafa, Chairman of Cotton and textile holding Company of Egypt; Mr Ahmed El-Bosaty, Chairman Modern Nile Company; Prof. Ali Hebeish, Chairman of the National Campaign of Textile Industries Improvement; Dr. Keshav Kranthi, Head Technical Information Section, ICAC and Dr. Mohamed Negm, Chairman of the network on cotton for Mediterranean and Middle East Regions. Dr. Negm and Dr. Moustafa welcomed the delegates. His Excellency E. Mohamed Badr expressed his happiness that the meeting was being held in Luxor and wished the conference success. Mr Kai Hughes stressed the need to make cotton more competitive through innovations to reduce environmental footprints, reduce cost of production and enhance yields. He emphasized that technological innovations through cotton research are necessary to compete with the advances being made by synthetic 'smart textiles' and 'functional textiles'. Prof. Ali Hebeish extolled the virtues of Egyptian cotton and its role in the economy. He recommended that the textile industry must support R&D in cotton improvement and production research. Mr Ahmed El-Bosaty stressed the importance of improving quality to sustain global leadership of Egyptian cotton. Dr. Kranthi appreciated the progress made on the development of varieties and agronomic practices that enabled high yields of premium quality cotton fibre in the Mediterranean region in a sustainable manner over the past few decades. He stressed the need to reinvigorate the sector to increase area, enhance yields and reduce water footprints and agrochemical usage to strengthen sustainable initiatives. Dr. Abdul Qayyum Rao, Assistant Professor, CEMB, Pakistan received the ICRA-Asia Young Scientist Innovation Gold Medal 2017. A progressive farmer Mr Haj Mohamed-Al-Seddik, was felicitated for producing Giza 45 sustainably over the past 15 years through organic farming techniques.

PARTICIPANTS: 125 participants from 15 countries comprising 43 overseas delegates registered for the meeting. Farmers, researchers, Government officials and representatives from the trade and textile industry from Egypt, Sudan, Belgium, Greece, Spain, Turkey, Syria, France, Germany, New Zealand, China, India, Pakistan, Bangladesh, UK, ICAC, UNIDO and UNICEF took part in the meeting.

SESSIONS: Nine sessions including inaugural and valedictory programmes were held during the three days.

SESSION 1: CHALLENGES TO THE COTTON SECTOR AND WAY FORWARD IN THE MEDITERRANEAN
Dr. Ahmed Mustafa & Dr. Michel Fok chaired the session.

Mr. Kai Hughes delivered the special inaugural lecture on 'The Traceability Challenge'

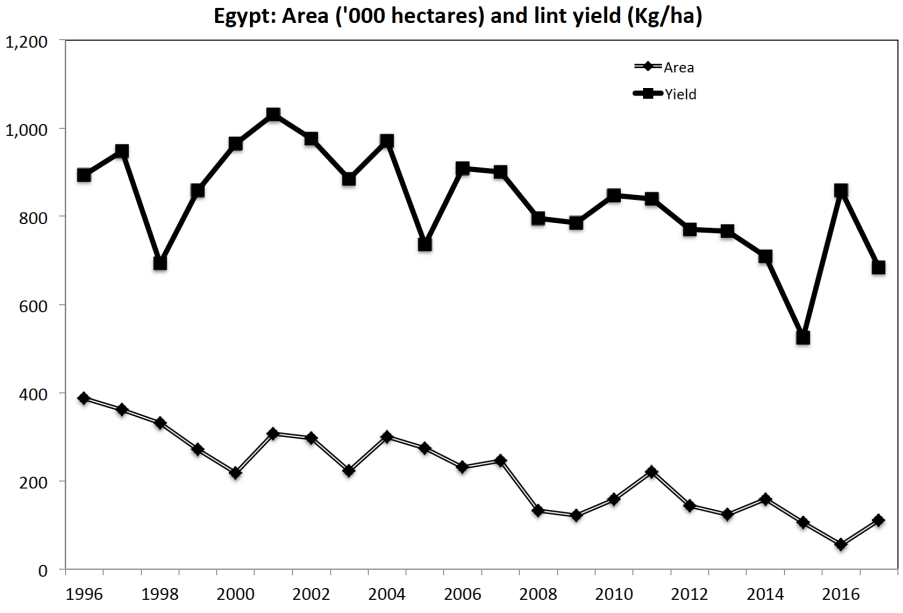
Researchers presented country reports and challenges faced by the cotton sector. Dr. Mohamed Negm, Egypt; Mr Konstantinos Dimitriou, Greece; Dr. Sema Başbağ, Turkey and Dr. Hasabo Ahmed, Sudan described cotton production practices of their respective countries and highlighted the key problems and prospects faced by the cotton sector. Dr. Keshav Kranthi highlighted the overall trends in cotton production in the Mediterranean and Middle East regions.

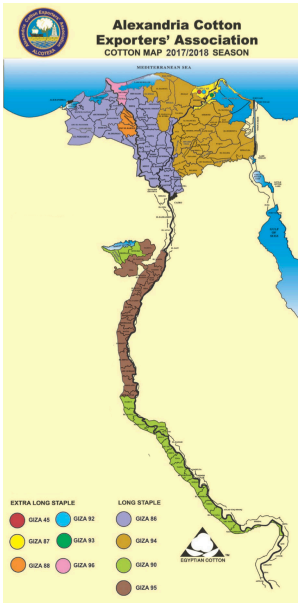
INAUGURAL LECTURE

Mr. Kai Hughes, delivered the inaugural lecture on 'The Traceability Challenge'. Traceability is the ability to verify the history, location, or application of an item by means of documented recorded identification. The disputed controversial claims of 100% Egyptian cotton made by an Indian company in recent years triggered a plethora of technologies that claimed to either identify the origins or authenticate the source or quantify and provide full supply chain knowledge of cotton fibres. At least three technologies namely 'Signature-T' of Applied DNA, 'Fingerprint' of Oritain and 'FibreTrace' by FibreMark solutions, have been commercialized. Mr Hughes provided an objective analysis of the three technologies and discussed their pros and cons with reference to identification, authentication, quantification and supply chain knowledge. He concluded that the combination of Fingerprint and FibreTrace technologies could lend robustness to traceability.

EGYPT REPORT

Dr. Negm presented the status report of Egypt. Cotton area in Egypt decreased from 390,000 hectares in 1996 to 55,000 hectares in 2016. The area doubled to 110,000 hectares in 2017. Yields averaged at about 900 Kg/ha during 1996 to 2006, but declined to 800 Kg/ha subsequently. Production declined from 340,000 tonnes in 1996 to 55,000 tonnes in 2016.





The current popular varieties are Giza 86 (63%), Giza 94 (17%), Giza 90 (10%), Giza 95 (5%) and Giza 87 (3%). Giza 45, which is grown in a small area, also under organic farming is known for its extra-long extra fine cotton with 36.0 mm length, 45.5 g/tex strength and 3.0 micronaire. GIZA 87, 88, 92 and 93 are extra long staple varieties, whereas Giza 86 and 94 which are grown in the Delta are long staple varieties. Giza 90 and 95, which are cultivated in the southern regions of Egypt are considered as medium and short staple cottons. The new variety Giza 96 is reported to be promising in quality and yields.

New initiatives such as HVI bale-certification, barcoding and traceability from field to bale are being taken to strengthen the cotton sector. The Egyptian textile industry is vertically integrated all through the chain. There are 2582,000 spindles in the spinning sector, which produce 205,000 tonnes of yarn every year. Egypt imports about 250,000 tones of yarn and exports 50,000 tonnes every year.

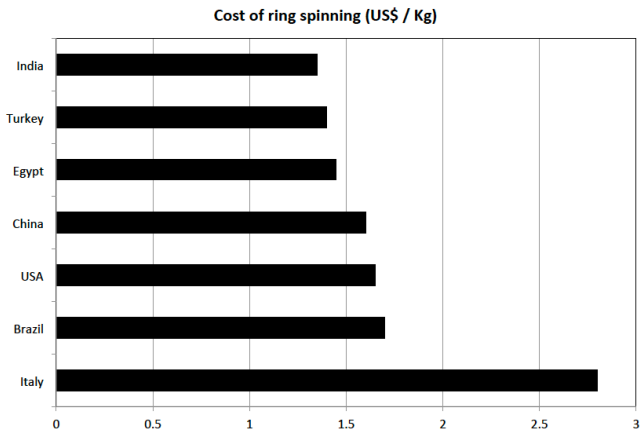
There are 4500 textile companies and 2525 textile plants in the country. The manufacturing cost of ring spinning is significantly lower than Italy, Brazil, USA and China but comparable to Turkey and India.

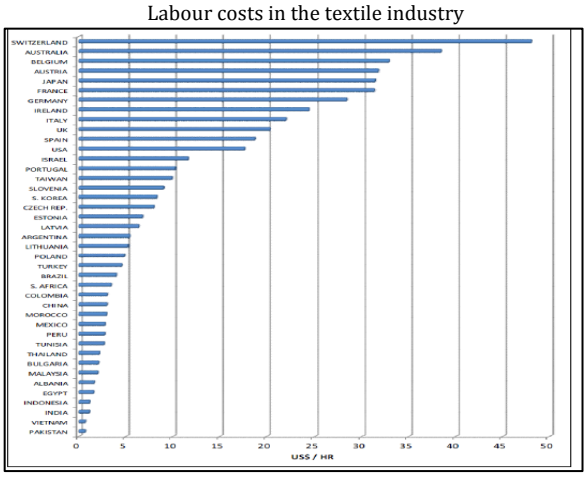
Table 1. Fibre quality of Egyptian cotton varieties

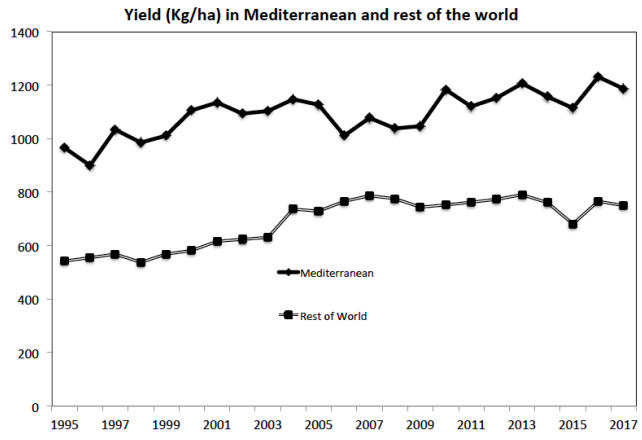
Variety	Category	Colour	Micronaire	UHML mm	Uniformity (%)	Strength g/tex	Elongation
Giza 45	Extra long Extra fine	White	3.0	35.3	88.1	45.5	6.3
Giza 87	Extra long Extra fine	White	3.2	36.0	86.1	46.5	6.4
Giza 88	Extra Long Staple	Creamy	3.8	36.5	87.5	46.2	6.5
Giza 96	Extra Long Staple	White	4.0	36.3	86.7	46.7	6.3
Giza 86	Long Staple	White	4.3	32.8	86.8	43.7	7.4
Giza 94	Long Staple	White	4.2	33.5	86.5	42.4	7.4
Giza 90	Medium Staple	Creamy	4.1	29.8	84.1	36.6	8.4
Giza 95	Medium Staple	Creamy	4.3	30.1	85.1	37.7	8.3

Table 2. Spinning sector in Egypt

	Public Sector		Private sector
Year	2017	2022	2017
Number of spindles	1,180,000	1,300,000	1,402,000
New spindles required	650,000		
Total production per year (Metric tonnes)	55,000	170,000	150,000
Total production per year (Metric tonnes)	200	560	500





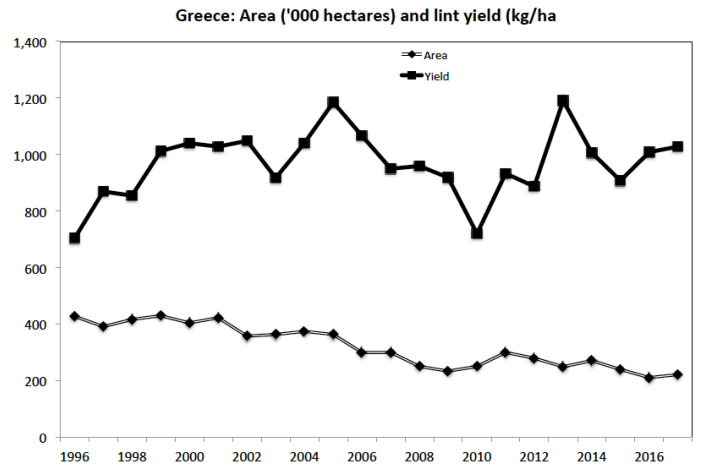


The labour costs and electricity costs in the textile industry are amongst the lowest in the world. It is claimed that Turkey and Egypt are most efficient in deliveries to Europe with two weeks as the average freight time, compared to 4-6 weeks taken by India, Bangladesh and China. The cotton Egypt Association licenses the use

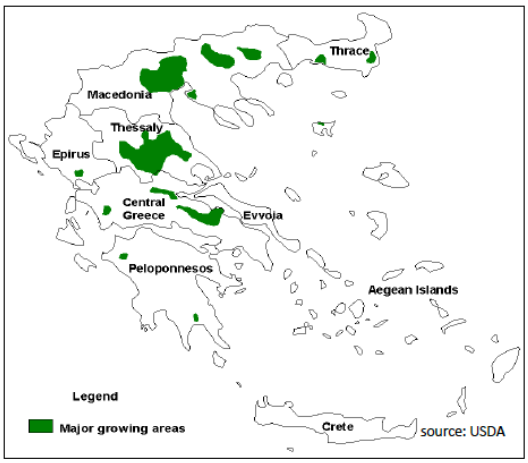
of 'Egyptian Cotton' logo authenticated by DNA testing. New Government policies and initiatives during the past two years have resulted in improvement of physical aspects of cotton and increase in area.

GREECE REPORT

Mr Konstantinos Dimitriou presented the status of cotton in Greece. He said that cotton was an important cash crop for 75,000 farmers and an economically valuable part of the total national economy in Greece. Cotton is grown in 250,000 hectares with 92.0% under irrigation. Cotton is grown in Thrace in the northeast, Macedonia in the north, Thessaly in central Greece and Levadia in lower Central Greece.



Cotton growing areas in Greece



With a production of 240,000 metric tonnes per year, cotton in Greece constituted 79.4% of the total European cotton production and 9.0% of Greek's final agricultural output. About 5-6 companies own 80-85% of the gins in Greece. All cotton is non-GMO, machine picked and contamination free. Cotton exports from Greece increased significantly by 4-fold to reach 260,000 tonnes after 1990.

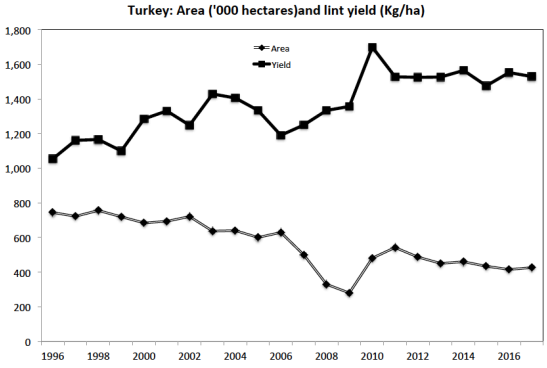
Production costs are high, but about half the costs are subsidized by the EU, which favored the expansion of cotton cultivation in Greece. Cotton crop is regulated for planting only on authorized land with certified seed. In 2017, the plant variety database of European Commission included 194 registered cotton varieties out of which 116 were from Greece. The new varieties are heat tolerant and require less water compared to corn. High density planting at 120,000 to 180,000 plants per hectare combined with warm climate and good sunshine result in high yields. There is a need to create a brand 'Made in Europe' to enhance the value of cotton in Greece.

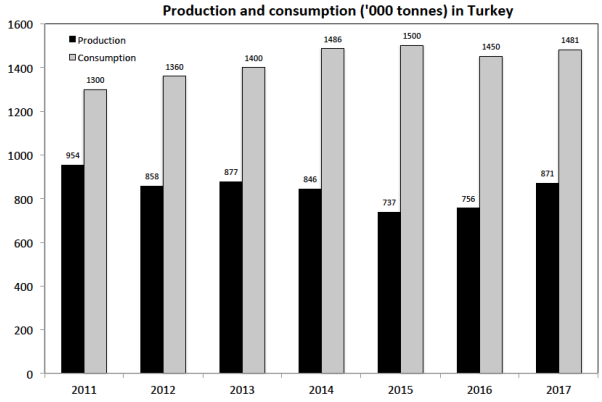
TURKEY REPORT

Dr. Sema Basbag described the history of cotton breeding and variety registration in Turkey. Cotton farming in Anatolia goes back to 330 years Before Christ (B.C). However, the main developments started during the period of Selcuk Turks in 11th and Ottoman Turks in 13th century. The most important developments in cotton farming have taken place as result of institutional regulations at beginning of the Turkish Republic in the 1920's. Cotton improvement research was initiated in 1924 mainly focusing on selection studies with 40 genotypes, which were introduced from the USA in 1927. The registration and certification processes for 'cotton seeds' started in the 1960's. Recent projects resulted in the development of new cotton varieties for improved yields, premium fiber quality, improved colored cotton and resistance to major insect pests and pathogens, particularly *Verticillium* wilt.

Cotton provides a direct source of livelihood to 3 million and indirect source of income to 12 million citizens in the country. Turkey contributes to 3% of the global production and constitutes 6% of the global consumption. Cotton is cultivated in three major areas with 61% in southeastern Anatolia (GAP) region, 23% in Aegean region of west and 16% in the southern Mediterranean region. The GAP region extends over wide plains in the basins of the lower Euphrates and the Tigris covering nine provinces.

Cotton growing regions in Turkey





Naturally coloured cotton in Turkey

Cotton area declined from 630,000 hectares in 2006 to 434,000 hectares in 2016. However, yields increased from 1190 Kg/ha in 2006 to 1664 kg/ha in 2016.

The EU (28) countries have a share of 62.1%, with UD$ 921 million in yarn exports in 2017. Turkey accounts for 13% of all global imports. Fibre exports from the country increased by 12.2% in January-October 2017, approximately valued at $ 491 million. Among the top ten export markets for yarn exports in 2017, exports to Belgium decreased by 3.2% and increased by 54.4% to USA.

A Total of 168 cotton varieties were developed between 1964 and 2017 in Turkey out of which 83 were released by public sector and 85 by the private sector. The 'Cotton Gene Bank' was established by Nazilli Cotton Research Institute in 2004. Approximately 20 varieties are commercially produced at present. All cotton is non-GMO, since transgenic cotton varieties are not permitted in Turkey due to the current biosafety laws. However, some transgenic varieties were tested in field experiments under controlled conditions in research institutes.

The focus of plant breeders has been on adaptation (30%), fiber quality (25%), earliness and second cotton crop (10%), resistance to drought and high temperature (10%), mutation breeding (8%), storage (5%), resistance to diseases and pest (5%) and tissue culture and molecular genetics (7%).

Table 3. Progress in plant breeding for fibre traits

Characters	**1980's**	**2017**
Cotton Lint yield (kg/ha)	750-800	1500-1740
Ginning percentage (%)	33-35	40-45
Fiber Length (mm)	22-26	29-32
Fiber strength (g/tex)	18-20	28-30
Fiber fineness (Mic.)	5-5.5	3.5-4.5

In the recent past, Turkey used to be a world leader in organic cotton production; but increasing global production has reduced margins, and domestic production has declined in recent years. Organic production in 2016 was estimated at 12,000 MT compared to 30,000 MT in 2006. Currently Turkey contributes to 7% of the global organic cotton production. Organic production in 2017 is expected to be about 15,000 MT. IPUD (Better Cotton Practices Association) was founded in September 2013 with focus on soil and crop health, integrated methods of cotton production, use of legal pesticides, correct, conscious and appropriate use of pesticides, optimization of water use, correct methods to harvest clean and high quality fiber and prevention of child labour.

The decline in cotton area in recent years is because of high costs, weak cotton prices, harvesting problems and climate change. High production costs are due to high land rents, fuel, fertilizer, herbicides, seeds, and labour costs. The production and use of cotton is influenced heavily by cotton politics, agricultural, industrial and trade policies and international developments. Increase in yields is because of new high yielding varieties, good agro-climatic conditions, mechanization, availability of irrigation water during the critical stages of growing season, improvement in plant protection, agronomic practices, fertilizers increased use of certificated seeds. The Ataturk dam provides irrigation for cotton in the GAP region.

SUDAN REPORT

Dr. Hasabo Ahmed presented perspectives on 'Sudan cotton crop developments during the last 10 years'. Cotton is one of the most important crops produced in Sudan. It has been the main foreign exchange earner contributing considerably to foreign exchange proceeds. More than 300,000 families in Sudan depend on cotton for their livelihood. Several other thousands are engaged in Cotton related activities. Cotton is grown in Sudan under various topographical and environmental conditions, utilizing various methods of irrigation, and using different applications of chemical inputs. It is cultivated in clay soil in Gezira, Rahad, New Halfa, Suki, Blue Nile, White Nile, schemes. In silt soil in Tokar of Eastern Sudan and in heavy clay soil in Nuba Mountains area of Western Sudan. Categorized by system of irrigation it is grown by gravity and pumps in Gezira, Rahad, New Halfa (Girba), White Nile, Blue Nile, and Suki Schemes; by flood irrigation in Tokar Delta and Khor Abohabil and under rain-fed conditions in Kurdofan, Darfour, Blue Nile, Senar and Gdarif.

The most popular varieties grown are; Barakat 90 (*Gossypium barbadense*), which represents extra-fine cotton category and covers 4% of the total cultivated area. The area under barakat 90 declined after the

introduction of Bt cotton. Currently Seeni 1, Seeni 2 Bt cotton varieties from China and Hindi 1 and Hindi 2 Bt cotton Hybrids from India comprise more than 95% of the cotton area. New Extra-fine cotton lines have been developed in recent years, with intermediate reaction to bacterial blight disease. The new varieties are endowed with longer, stronger and finer fibers compared to Barakat-90 with early maturity that gives 45.6 to 61.2 per cent of the yield in the first picking compared to 43.5 for Barakat-90. Hence these lines signify improvement in seed cotton yield, fiber quality, earliness of maturity and reaction to bacterial blight in Sudan extra-fine cotton.

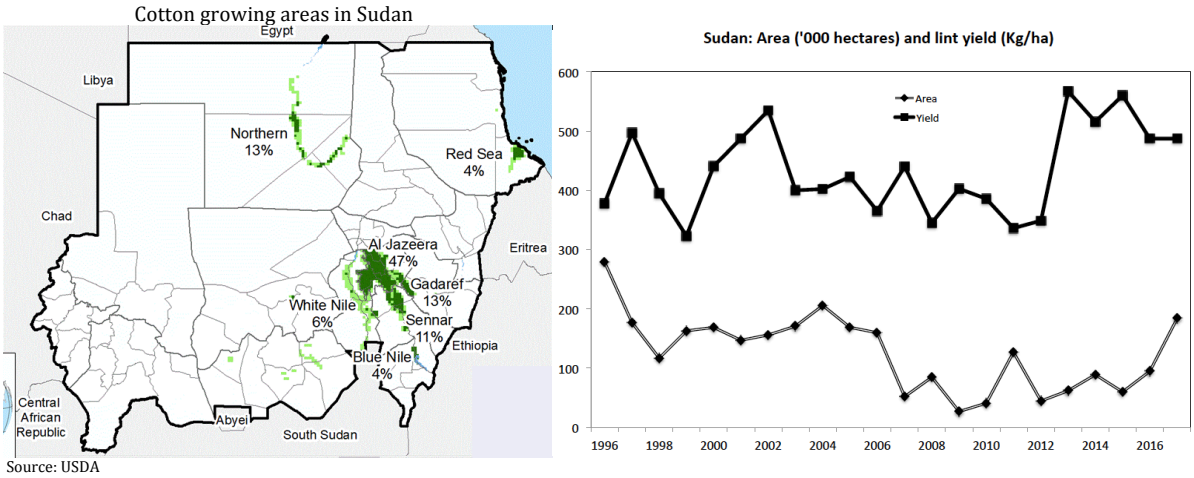


Table 4. Fiber properties of the commercial varieties

Variety	Length (mm)	Mic.	Strength g/tex
Hindi 1 (hybrid)	28.3	4.4	30.2
Hindi 2 (hybrid)	29.1	4.6	29.8
Seeni 1	27.9	4.5	27.9
Seeni 2	27.1	4.9	27.

Climate change effects are reflected in rainfall amount distribution and patterns. These changes have affected sowing date and appearance of new insect pests. Cotton insect pest complex in Sudan has changed; bollworms and leafhoppers (jassids) are no longer the main insect pests. Recently, cotton Mealy bug and Bacterial blight have emerged as the new concerns. The main goal of integrated management is to maintain plant health through coordinated tactics in crop production and protection system. More emphases have been given to extra-fine cotton research in view of its immense importance in the marketing policy of Sudan.

During the last 10 years Sudan cotton area, productivity and production fluctuated sharply. The area was 23,300 ha in 2009-2010, with a small volume of production of less than 10 tonnes. In 2011, the area increased to 123,000 ha but the production was only 42,000 tonnes. Area increased to 184,000 ha in 2017-18. The revival of the present cotton production situation in the Sudan has been attributed to reforms initiated by the Government in the five-year economic reform program 2015-2019 which put more emphasis on cotton production improvement. As a result of introduction of *Bt* cotton and the new policies, cotton became the most profitable crop; therefore, farmers are now more interested in cotton cultivation.

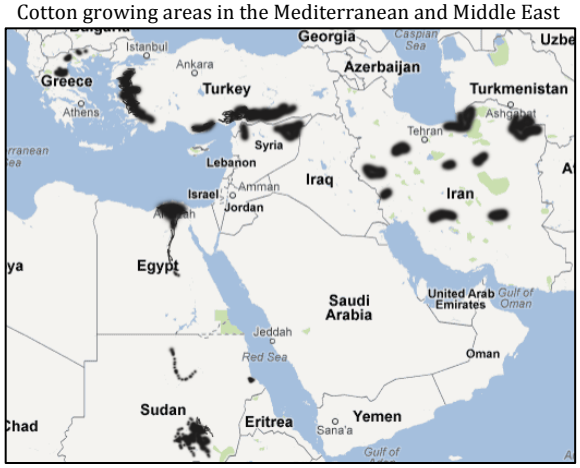
MEDITERRANEAN OVERVIEW

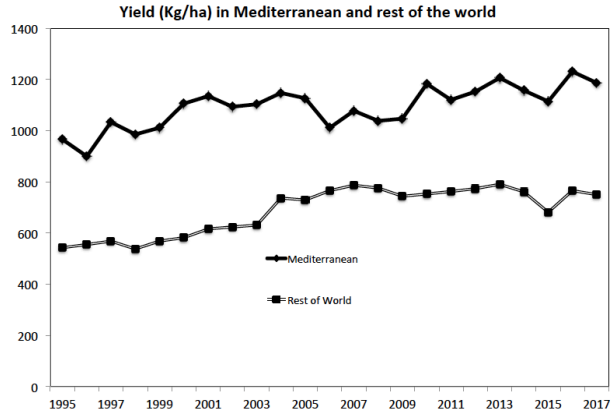
In his presentation on 'The Mediterranean White Gold' Dr. Keshav Kranthi gave a brief overview on cotton production in Mediterranean and Middle East regions and highlighted the strengths, challenges and research focus for the region. Yields in the Mediterranean region have improved constantly from 385 Kg/ha in 1954 to 1240 Kg/ha in 2004.

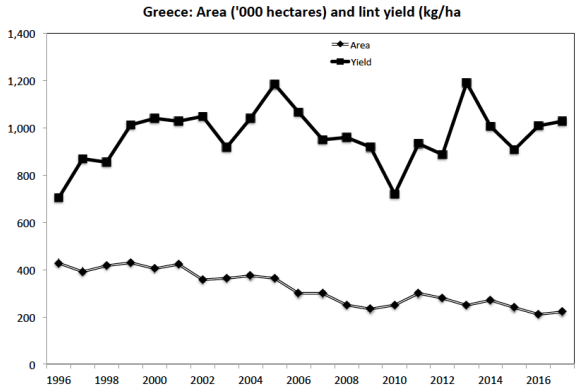
Israel, Turkey and Greece have provided examples of tailoring technologies towards sustainability and high yields. Cotton area in the eight main growing countries of the Mediterranean and Middle East regions,

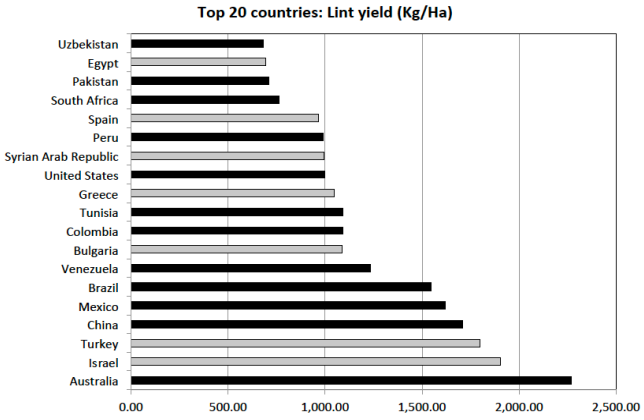
decreased from 2,475,000 hectares in 1996 to 904,000 hectares in 2016. The area in Egypt declined from 798,000 hectares in 1965 to 387,000 hectares in 1996 to a low 55,000 hectares in 2016. Similarly, the area in Greece, Turkey, Sudan, Spain, Iran, Syria and Israel declined by 50-60% during the 20 years from 1996 to 2016.

Cotton growing areas in the Mediterranean and Middle East









One of the main reasons for the reduction in area is believed to be the increasing cost of production in the regions. Greece, Israel, Iran, Egypt and Turkey rank amongst the top twenty countries, which have highest cost of production in the world. One of the major concerns is the excessive use of water and agrochemicals. Sudan, Iran, Egypt, Turkey, Spain and Greece rank amongst the top 10 countries that use the highest quantity of water per unit of cotton production. Agrochemical usage is on the rise in the region. Pesticide and fertilizer use in Egypt increased by at least 4-fold over the past decade. With the current emphasis on sustainability, cotton production systems in Egypt, Turkey and Greece need the attention of researchers to develop technologies that can reduce the use of agrochemicals and water, without compromising yields and fibre quality. The introduction of *Bt* cotton technology in hybrids in Sudan has changed the insect pest profile in the country. Dr. Kranthi cautioned that experience in India points out to the possibility of resurgence in secondary pests and increase in Bacterial blight and pink bollworm in the near immediate future in Sudan if proper care is not taken to approve locally adaptable short-season *Bt*-varieties and *Bt*-hybrids.

SESSION-II: GENETIC ENGINEERING

Dr. Naguib El-Banna & Dr. Eleni Tsaliki chaired the session.

In a special talk Dr. Abdul Qayyum Rao described successful efforts at CEMB Pakistan to control insect pests and weeds by genetic modification of local cotton varieties through introduction of codon optimized Cry1Ac, Cry2A and cp4 EPSPS genes under the control of CAMV35s promoter. Introduction of plant lectin genes to control sucking pests and gene silencing approaches using RNA interference (RNAi) conferred only partial control of 70-80% against the dreaded cotton leaf curl virus (CLCuV). Application of CRISPR CAS 9 System against leaf curl virus is in progress to strengthen approaches to control CLCuV.

In his talk on 'Transgenic Cotton: Gateway to Sustainable Cotton Production-Experience India' Dr. Vijay Kumar gave an overview of the success story of *Bt* cotton in India to state that *Bt* cotton in India evoked a new discussion in the civil society about propriety of *Bt* cotton and other biotech products; but one has to accept the fact the technology benefitted farmers and the country. There might be lacunae in the technology and or its adaption but we have to weigh the pros and cons of the technology on a sustainability criterion. He concluded that no technology or product is risk free, especially, if it is over exploited.

Dr. Michel Fok spoke on 'Twenty years of GM varieties use: Lessons learnt' and summarized the global experiences on the benefits and concerns due to GM cotton across the world. Quantitative evolution is claimed to be a clear indication of the global positive impacts of the use of GM varieties. This criterion is complemented by other claims related to the global decrease of the pesticides use, global production increase and economic gain and reduction of greenhouse gas emission. Ecosystem reacts to the way GM varieties are being used; the pest complex shift and the emergence of weeds resistant to herbicides are illustrations of ecological reactions to the mis-management of GM varietal use based on general and continuous use. He concluded that if GM varieties were to be used, the best way is partial use and that the influence of GM cotton should be assessed for its short-term and long-term effects to clarify the technological impact on the environment, economy and social aspects.

Dr. Youlu Yuan presented his work on construction of high-density genetic map in upland cotton and Its application to genetic regulation analysis for yield and fiber quality traits. A population of 196 recombinant inbred lines (RILs) was developed from a cross between 0-153 and sGK9708. Three methods, namely, new simple sequence repeats (SSR) markers, cotton 63K chips and specific locus amplified fragment sequencing (SLAFS) were used to construct a high-density genetic map with the RIL population. The map constructed by SSR markers harbored 997 markers with a total genetic distance of 4,110 centiMorgans (cM) with an average distance of 5.2 cM between adjacent markers. A total of 165 quantitative trait loci (QTLs) of fiber quality traits were identified with this map and 47 of them were stable that could be detected in at least three different environments. Based on the high-density map, the genetic regulation and the relationship of fiber quality traits with yield traits could be explained.

Dr. Abdelmoghny described morphological, physiological, biochemical studies and quantification of gene expression under drought stress in upland *G. hirsutum* cotton in India. Using the drought tolerance selection indices, 891/IC357406, Nagpur-9, 28I and Suraj genotypes were found to be significant for desired drought tolerant traits. Six genes *GhZFP1, GhDREB1A, GhWRKY17, GhNAC9, GhSuT1* and *GhNCED* were found to be up-regulated under drought stress. Based on morphological, physiological, biochemical and molecular biological studies, the genotype 891/IC357406 was identified to be the most tolerant genotype.

SESSION III: FIBRE PROPERTIES AND NANOTECHNOLOGY

Dr. Ali Hebeish & Dr. Suzan Sanad chaired the session.

Dr. Elenei Tsaliki presented her talk on evaluation of fiber and yarn technological properties of seven promising new cotton strains and advanced Greek cotton lines, which were cultivated in experimental fields in Thessaloniki Greece. Data indicated that the cotton genotypes have high yield and fiber properties that ensure their commercial success and are being processed to be included in Greek National Catalogue.

Dr. Lale Efe compared the fiber characteristics of (*Gossypium hirsutum* L.) cultivars, Lydia, Carisma, PG 2018, Flash, BA 440, BA 119 Maraş-92 and Erşan-92 ginned by using saw gin and roller gin in Turkey. The ginning outturn (38.6 %), upper half mean length (30.21 mm), uniformity index (86.02 %), fiber strength (31.76 g/tex), spinning consistency index (SCI) (104.68) as determined for the fibre obtained by using roller gin system were found higher than the ones determined for the fibre obtained by using saw gin system (respectively 37.2 %, 29.78 mm, 84.61 %, 30.97 g/tex, 94.50). Short fiber percentage (3.47 %) and neps count (59.40 count/g) obtained for fibres from roller gin system were found lower than those for the fibres obtained from saw gin system (respectively 4.38 % and 119.34 count/g). Results showed that the roller gin method has positive effect on ginning outturn, upper half mean length, uniformity index, fiber strength, spinning consistency index, short fiber percentage and neps count.

Dr. Salah M Saleh spoke on the application of nanocellulose in textiles. The innovative potential of nanotechnologies offers a wide range of opportunities for the textile industry for improvement in professional and general public users by either integrating nano-engineered materials into the polymer matrix or coated onto the surface of the fibres. Nano-cellulose treatment offers possibilities such as improved durability, self-cleaning, and water or dirt- repellent features. Through the manufacture of smart or e-textiles, nanotechnology-enabled apparel can both protect the wearer from pathogens, toxic gases and other hazardous substances, benefiting the medical and rescue services as well as in the military to allow constant monitoring of body functions in applications ranging from regenerative activities to the enhancement of the quality of life of sufferers of long-term diseases. In the field of agriculture and crop optimization, nano fibers that have the ability to absorb plant protection products are applied to achieve controlled slow release functionalities.

Dr. Susan Sanad compared results of a new Egyptian long staple cotton variety with Pima extra long staple variety. Quality characteristics such as the structural properties (yarn count, yarn twist and number of end breakage/1000spindle hour), unevenness properties (CV% values, thin and thick places, neps, hairiness) and the physico-mechanical properties (tenacity and elongation at break) were determined, and statistically analyzed. The spinning potential of Giza 94 (long Staple Egyptian cotton) was found to reach up to 170Ne satisfactorily, while the maximum spinning potential of Pima (Extra long Staple) could only reach up to 120 Ne.

SESSION IV: ABIOTIC STRESS & CLIMATE CHANGE

Dr. Hasabo Abdel Baqui and Dr. Venugopalan chaired the session.

Dr. M. V. Venugopalan presented a talk on 'climate change and cotton production in India: impact analysis and adaptation strategies'. Climate change will have varying impact on cotton as a result of complex interactions between higher concentration of carbondioxide, increase in temperature and altered rainfall patterns. Simulation modeling using 'InfoCrop' model showed that at the national level, under irrigated conditions, a combination of optimizing sowing time, switching over to short duration varieties and improved inputs could enhance yields by 20.5 % and 16.3% respectively for 2050 and 2080 scenarios. Under rainfed conditions, compared to the present scenario, improved management strategies viz. short duration, compact varieties and early sowing dates, have a potential to increase the rainfed cotton yields by 22.8% and 21.7% in the 2050 and 2080 scenarios respectively.

Dr. Asia Perveen described heat tolerance in cotton cultivars using physiological and morphological aspects in Pakistan. Twenty-one transgenic cotton genotypes were evaluated for high temperature stress tolerance based on morphological and physiological characteristics under field conditions during 2016-17. The relative cell injury level (RCIL) varied from 39 to 87%, electrical conductivity (EC) of leaves varied from 168 to 403 μS cm^{-1} and pollen viability ranged from 53 to 82%. Data indicated that pollen viability, cell membrane thermo-stability (CMT) and electrical conductivity (EC) can be used as heat tolerance indicators in cotton genotypes to improve and sustain cotton production under thermally stressed environments. The results of the present study revealed that NIAB-878, NIAB-1064 and Deebal cotton varieties had comparatively more thermal stress tolerance as these varieties maintained lower relative cell injury levels (higher cell membrane thermo-stability) and higher seed cotton yield.

Dr. Wuwei Ye spoke on improvement and identification of drought- & salinity-tolerance on Cotton in China. Three salt-tolerance related genes, *ccmC, rps12* and *nad3* were isolated from mitochondria of *Gossypium hirsutum* varieties ZhongH177 and Zhong9835 and cloned. Over-expression vectors pBI121-rps12, pBI121-ccmC and pBI121-nad3 were constructed and transferred into cotton cells using gene gun transgenic technology to analyze salt-tolerant molecular mechanisms.

Dr. Sema Basbag described the effects on physiological properties of drought stress. Cotton varieties (Stoneville 453, GW Teks and Deltaopal) were evaluated for stress tolerance at 100%, 80%, 60% and 40% levels of irrigation water. A quadratic relationship between drought stress and plant height, stem diameter, leaf area index, photosynthesis yield, boll number and a linear relationship between water stress and leaf temperature properties was observed.

Mr Phillip R Walesby described Bioclasp™ technology as a new edge environment friendly technology for sustainable production of cotton and mitigating changing climate. The product was shown to help applied and native chemicals and nutrients to retain efficiacy for longer time, thereby enhancing efficient use of inputs.

SESSION V: FIBER BREEDING
Dr. Abdelrahman latif and Dr. Hassan El-Adly chaired the session.

Dr. Muhammad Tehseen Azhar described Metroglyph analysis to study genetic diversity, yield related parameters and CLCuD among upland *Gossypium hirsutum* cotton genotypes grown under field conditions. The genotype IUB-222 showed resistance while IR-3701, CRS-2007, CIM-599 and VH-289 showed moderate resistance, while S-12 was highly susceptible to CLCuD. Two most variable characters i.e. short fiber index and seed cotton yield were used to draw Metroglyph scatter diagram for the formation of six diverse groups which revealed the presence of genetic variability. The genes from superior lines could be pyramided by hybridization for CLCuD tolerance in addition to yield and other fiber quality traits.

Dr. S. M. Palve described the genetic variation for fibre properties in breeding lines of cotton (G. hirsutum L.) in India wherein breeding lines with higher fibre strength and elongation were developed compared to standard varieties such as Suraj and NH 615 which had fibre strength of 32.1 g/tex and 26.9 g/tex respectively.

Dr. Sima Kundu described the selection of short duration *G. hirsutum* genotypes for breeding program in Bangladesh. An experiment was carried out at Cotton Research Farm, CBD, Gazipur during the cropping season of 2016-17 to evaluate the performance of 25 short duration cotton genotypes selected from 100 genotypes in the year 2015-2016. Considering earliness and other yield contributing characters, eight cotton genotypes (BC-0349, BC-0378, BC-0382, BC-0386, CB-14, SR-15, CC-8 and Win all 6) were selected as parents for future breeding program.

Dr. Dharminder Pathak spoke on 'alien introgression in cotton' for insect pest resistance. Dr. Pathak informed that interspecific hybridization between *G*. *hirsutum* and *G*. *arboreum* was difficult; and hybrids between *G*. *hirsutum* and *G*. *armourianum* were produced but were generally sterile. The BC_1F_1 and BC_2F_1 progeny of *G*. *hirsutum* and *G*. *armourianum* segregated for CLCuD resistance. Similarly, backcross derivatives between American cotton and synthetic amphiploids segregated for their reaction to CLCuD. Only four interspecific hybrid plants were obtained after attempting several thousand pollinations.

Dr. Neima Osman spoke on cotton grades and quality parameters of Acala variety as affected by boll position in Sudan. Results showed that, seed cotton obtained from upper zone had better grades than middle and lower zones.

Dr. Ercan Efe described a statistical method through planned comparisons of different groups using contrast coefficients using local and mutant Azerbaijan cotton varieties, Maraş92 (local non-mutant), Ağdaş21 (*G. barbadense*) and two *G. hirsutum* varieties Ağdaş3 and Ağdaş17. In terms of fiber fineness, the mean of local non-mutant varieties and the mean of mutant Azerbaijan varieties were found to be similar ($P>0.05$); the mean of mutant *G. barbadense* variety and the mean of mutant *G. hirsutum* varieties were found to be different ($P<0.05$) and means of mutant *G. hirsutum* varieties were found to be similar ($P>0.05$).

SESSION VI: **AGRICULTURAL PRACTICES**
Dr. Lale Efe and Dr. Usha Rani chaired the session.

Dr. Felipe R. Montero described the advantages of interspecific hybrid cotton varieties in the Mediterranean area under pivot irrigation system. Extra long staple (ELS) fiber production began in Spain in 2007 and reached 5.500 hectares in 2016 with an average lint yield of 1,600 kg/hectare. The study deployed Low energy precision application (LEPA) irrigation to evaluate its impact on the varieties studied in both performance (kg / ha) and fiber characteristics (HVI system). Hybrids (HA-1432, HA-211, HA-670, HA-701, GW-2002, GW-2005, GW-2007, GW-2008 and GW-2012); *G. barbadense* (Armada and E-1) and *G. hirsutum* (Elpida and Campo) were used in the trials. The trials clearly demonstrated higher efficiency of the pivot system and superiority of the interspecific hybrids over the *G. hirsutum* and *G. barbadense* varieties.

Dr. Khaled Shalabi presented the effects of different span sizes on irrigation performance of center pivot in 63 hectares. Nine configurations of center pivot with different spans sizes of 6-5/8" and 8-5/8" were hydraulically tested. Results showed that 77.0% of the total area of 63 hectares was irrigated by the last four spans and the overhang while the first four spans covered only 23.0% of the total area. 90% of the cumulative friction loss occurred in the first five spans when the 6-5/8" pipe size spans were configured with the center pivot. The lowest cumulative friction loss of 0.8 bar occurred when using 7 spans 8-5/8" pipe size and last two spans as 6-5/8". 33.0% of the annual operating cost was saved at the same configuration. Payback period was obtained as one year by using five spans 8-5/8" pipe size, while it increased to two years by using seven spans of 8-5/8" pipe size.

Dr. Usha Rani described past experiences, present endeavors and future options in transfer of cotton technologies towards science-led sustainable development in India. The exclusive mission mode approach and dissemination of modern cotton biotechnological technologies, production and protection innovations by utilizing ICT tools enabled the country to acquire the status as the world's top most cotton producer. Recent changes in the cotton sector pose enormous challenges that call for a paradigm shift, from merely providing materials and information to facilitate inclusive training that can enable the small and marginal Indian farmers to double their yield and triple their income from cotton. A blend of time-tested simple "farmer to farmer extension" in combination with complex TOT approaches using modern ICT tools in the form of Integrated Extension Management Services, robotics, autonomous and intelligent machines to share information and labor in cotton farming along with novel structured buy back system could serve as the future exertions needed for Science-led sustainable development of Indian cotton.

Dr. Tabib FAI described evaluation of different weed control methods that were conducted during 2013-2015 in cotton fields in Bangladesh. He concluded that pendimethalin, glyphosate and paraquat were effective and economical to control Bermuda grass, *Cynodon dactylon* and Nut sedge, *Cyperus rotundus*.

SESSION VII: NEW TECHNOLOGIES
Dr. Ahmed Mostafa and Dr. Mohamed Negm chaired the session.

Eng. Khaled Schuman described new initiatives to protect and promote the Egyptian cotton heritage. Cotton Egypt Association is a non-profit association that was established in 2005. CEA exclusively manages the registered Egyptian Cotton™ logo trademark, that is jointly owned by the Ministry of Trade and Industry and Alexandria Cotton Exporter's Association. CEA has adopted fully transparent traceability systems that audit to CATGO lot numbers. Bureau Veritas audits the Egyptian Cotton™ traceability throughout the entire supply chain using an exclusive DNA testing methodology thereby ensuring the authenticity of Egyptian Cotton™ by verifying Egyptian Cotton Varieties all through from fibers to the finished products. The DNA fibre typing method has a lower cost compared to the cost of other methods that ranges from US$ 4.3 million to US$ 21.6 million for 60,000 tons.

Mr. Hermann Selker described the recent advances in spinning preparation technology as exemplified by Trützschler, which has 130 years experience. The company specializes in spinning preparation with about 3,000 employees, four production sites in Germany, four production sites in USA, Brazil, China and India, in four business units of spinning, non-wovens, man-made fibers and card clothing.

POSTER SESSION
Three posters were displayed.

Dr. El-Banna compared three different cotton grades with four temperature levels to investigate their effect on HVI fiber properties of Giza 95. Results indicated that the cotton grade, Good to Fully Good (G/FG) surpassed the other two cotton grades and gave the highest mean values of upper half mean length (U.H.M.), length uniformity index (U.I.), fiber bundle strength, fiber elongation (%), maturity index (%), micronaire reading, HVI color attributes (fiber reflectance degree (Rd %) from the highest cotton grade, Good to Fully Good (G/FG).

Dr. El-Banna described the effect of spinning systems and spinning processing on the fiber and yarn properties of Egyptian cotton. 100% Giza 86 Egyptian cotton variety was used to produce conventional ring

card yarn and card compact yarn to fabricate 40 Ne count of yarn both for conventional ring and compact spinning respectively. The positive effect of spinning process on the yarn properties was evaluated by co-efficient of variation (CVm %), imperfection index (IPI), hairiness, tenacity, and elongation (%). The results showed that yarn qualities of compact spinning were superior to conventional ring spinning.

Dr. El-Gabry presented a poster on production of multifunctional viscose fabric by using nanoparticle materials namely; nano clay, nano chitosan and nano cellulose by mixing nanoparticles with reactive cyclodextrin (RCD) in the presence of sodium carbonate (Na_2CO_3) . Viscose fabric was treated with this solution in one step and or two steps using pad-dry-cure technique. Particle size of the nano-materials along with chemical composition, mechanical properties, physical properties and dyeability of the treated viscose were performed using world-class tools and facilities. The FTIR spectra of treated fabrics were also examined to suggest changes in the treated viscose fabrics.

VALEDICTORY SESSION

In his valedictory address Mr. Kai Hughes congratulated the participants of the Mediterranean and Middle East network for the useful presentations and deliberations. He drew the attention of the participants to the strategic review being conducted at the ICAC and urged them to actively contribute ideas and thoughts to improve the functioning of the ICAC to benefit the global cotton sector.

Dr. Keshav Kranthi congratulated and thanked Dr. Negm and his team for the excellent arrangements. He said that the regional networks were designed with objectives to foster friendship and contacts amongst researchers and also to exchange technical knowledge and experiences in solving intractable problems of the region. He said that the dream of his predecessor Dr. Rafiq Chaudhry to establish a global cotton research institute could come true if the textile industry decides to support the initiative. He asked the researchers of the Mediterranean region to consolidate on their strengths in cotton and to sustain leadership in premium quality and high yields by developing sustainable cultivation practices.

Dr. Michel Fok informed that the ICRA Secretariat was fully functional now. He invited researchers to actively participate in the ICRA activities and asked them to address all aspects of the cotton sector to make it more competitive. He said that the competition from synthetic fibres could be effectively counter-acted by streamlining the social, economic and environmental footprints of cotton production practices.

Mr. Kai Hughes announced that Dr. Mohamed Negm would continue as the Chair and General Coordinator of the Mediterranean and Middle East network until the next meeting to be held in 2021.

RECOMMENDATIONS

1. **CULTIVATION AREA:** There are good prospects to double the cultivation area in the Mediterranean region by lowering production costs to make cotton more competitive thereby regaining areas that that were grown two decades ago.
2. **TRACEABILITY:** Traceability technologies are imperative for the region to regain consumer confidence and consolidate the brand value of 'European Cotton' and 'Egyptian Cotton'. Adopting appropriate traceability technologies will ensure authenticity and identity of premium quality cotton produced in the region to sustain global leadership.
3. **CLIMATE CHANGE:** Cotton varieties tolerant to drought, heat and salinity must be developed to reduce the current water requirements and also for preparedness to combat the impending effects of climate change in the long run.
4. **PREMIUM FIBRE QUALITY:** Researchers of the Mediterranean region should strive to retain the leadership position in premium quality fibres by continuously striving to develop adaptive high yielding varieties of superior fibre quality.
5. **COST OF PRODUCTION:** There is a need to intensify research to lower down the cost of production to enhance the competitiveness of cotton.
6. **IRRIGATION WATER:** Water footprints in the Mediterranean region need to be reduced through moisture conservation practices and advanced irrigation technologies.
7. **SUSTAINABILITY:** Researchers of the region, especially Egypt, Turkey and Greece should focus on optimizing efficient use of agrochemicals such as fertilizers and pesticides to improve sustainability of cotton production systems.
8. **PROPER GMO DEPLOYMENT:** Researchers of Sudan should strive to work on using native varieties for deployment of GMO so as to ensure high adaptability and also to prevent emergence, occurrence and resurgence of new insect pests and diseases. Efforts must be made to develop and utilize short season varieties that for easier pest management and nutrient management.
9. **GMO EXPERIENCES:** Mediterranean countries should consider experiences of GMO cultivation gained by major cotton growing countries as lessons for appropriate deployment of the technology if needed.
10. **MARKER ASSISTED BREEDING:** Advanced knowledge gained through genomic sequencing and QTL mapping must be used by the plant breeders to develop premium-quality, high yielding, multi-adversity resistant cotton varieties.
11. **BIOTECHNOLOGY AND NANOTECHNOLOGY:** Researchers of all disciplines must explore Biotechnology and nanotechnology to make cotton production and processing systems more efficient and to develop smarter cotton products of greater functional value.