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News

WORLD COTTON DAY -October 7th

Geneva, 6 October 2021 - The International Trade Centre (ITC) and the International Cotton Advisory Committee (ICAC) commend the United Nations General Assembly resolution (A/RES/75/318) for officially recognising 7 October as World Cotton Day.

It is a historical moment to acknowledge the importance of cotton as a global commodity as well as its vital role in several countries. Cotton generates income and subsistence for millions of people worldwide and has broader economic and social impacts around the world.

The cotton sector provides income for millions of people in Africa, especially those living in rural areas, women and youth working throughout the cotton value chain. Additionally, it is an essential source of foreign exchange earnings.

World Cotton Day contributes to raising awareness in the international community about the valuable contribution of sustainable cotton in achieving the 2030 Agenda for Sustainable Development.

Quotes

'Cotton is one of the world's most actively traded commodities. This simple crop touches the lives of millions of people globally. Cotton has tremendous trade potential, ranging from fibre to clothing or cattle meal to oilseed; cotton is a strategic crop for many African economies, generating income and employment for millions of rural families, women producers, as well as export revenues for producing countries.

'At ITC, we have seen the benefits of our work for small scale farmers in Africa. And we have witnessed the changes it has made in their lives. We've helped them to grow sustainably and add value to their products. Cotton embodies the heart of our work. We strive to empower small businesses throughout the cotton value chain for better lives while creating a more sustainable future'.

Pamela Coke-Hamilton, Executive Director, International Trade Centre

'The theme for World Cotton Day 2021 is 'Cotton for Good' and provides us with an opportunity to shout about the positives of cotton. Not only does cotton provide a livelihood and food security to millions of small farm holders in Africa and Asia but it can be recycled and reused and returned to the earth to biodegrade naturally unlike synthetic fibres. Cotton also sequesters more carbon in the soil and its biomass than it produces as it grows, making it a critically important ally in the fight against climate change. In fact, clothing and bedding are literally only half the story when it comes to cotton as many things that we touch may also have a by-product of cotton in it from cooking oil to animal feed to lipstick. No other natural product can boast of such versatility and World Cotton Day is the perfect time to recognise not only the positives it brings to our lives but especially to the hundreds of millions of people in least-developed countries who depend on cotton'.

Kai Hughes, Executive Director, International Cotton Advisory Committee (ICAC)

Background

On 30 August 2021, the United Nations General Assembly adopted a resolution (A/RES/75/318). The proposition to officialise the date was led by the Cotton Four or C4 — Benin, Burkina Faso, Chad, and Mali, leaders in cotton production — plus Côte d'Ivoire. However, prior to the UN decision, the date was already unofficially celebrated as, in 2019, the International Trade Centre together with the UN Food and Agriculture Organization (FAO), the United Nations Conference on Trade and Development (UNCTAD), the World Trade Organization and the ICAC launched World Cotton Day to reflect the importance of cotton as a global commodity.

Source: www.worldcottonday.com &Mike McCue Mike@icac.org

The European Cotton Alliance (ECA) and the EUCOTTON ™

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The official presentation of the European Cotton Alliance (ECA) and the EUCOTTON™ has been held at a special event in Brussels at the European Parliament, on October 16, 2019. Two years later and while most countries are facing unprecedented challenges, the initiative gains momentum and becomes more relevant than ever ….

Founding Members

The Alliance has been established at the beginning of February 2019 with the participation of various associations representing the cotton sector in Europe, the production of cotton and the textile industry.

Founding members of the Alliance are:

- The Greek Inter-Professional Association of Cotton (DOB),
- The Hellenic Cotton Association of Ginners and Exporters (HCA),
- The Federation of Greek Textile Industrialists (SEVK),
- The Spanish Association of Cotton Ginners (AEDA),
- The Association of Spanish Cotton Ginners of the South (ADESUR) ,
- The National Cotton Centre in Spain (CAN),

In addition, EUROCOTON, the European Association of textile manufacturers in Brussels, agreed to join the Alliance as an associate member through a special partnership agreement.

Aims and Objectives

The most important aims and objectives of the Alliance according to the provisions of the Statutes of the Organization are:

- ✓ To contribute to the harmonization of the European policies in relation with the cotton production in the whole of the EU member states.
- ✓ To promote and increase the cotton production in the EU through sustainable and environmental-friendly practices and traceability of production.
- ✓ To establish the harmonic collaboration and cooperation among the cotton producers and the textile industries involved in the processing of cotton.

However, as the primary objective of the Organization is:

- ❖ To increase the awareness and recognition of the European Cotton with a strong focus towards its quality properties.
- ❖ To develop a European Cotton Collective Trademark that will contribute to the identification of the Cotton produced in Europe (EUCOTTON™).
- ❖ To implement a branding and promotional strategy that will target to communicate its identity values to the manufacturers, the retailers and the consumers in a meaningful way.

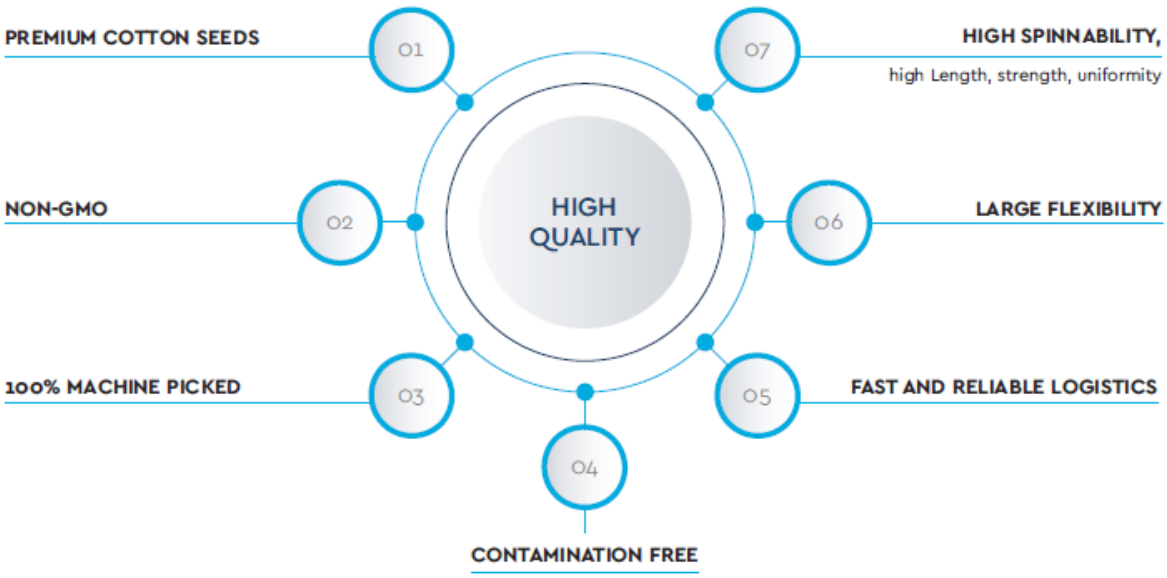
Values related with:

- Its inherent (tangible) quality in terms of its high spinning value and
- Its intangible quality in terms of the responsible way it is produced respecting high environmental and social standards.

INHERENT QUALITY OF EUROPEAN COTTON

It is worthwhile mentioning that regarding its inherent quality, European cotton:

1. Has very good spinning performance with large flexibility in a number of mix laydowns.
2. Both Greek and Spanish are machine picked with good uniformity ratio, low short fiber index and;
3. Good Length, Strength and Micronaire values.
4. They are perceived to be almost zero contamination, or contamination free cottons, since the process from the very first stage of sowing up to harvesting, ginning, packaging and storing is highly mechanized with good standards of automation and repeatability.
5. Moreover, logistics are very fast and reliable for both countries ensuring prompt deliveries to every destination. The statement "same day shipment" is not an exaggeration. There have been numerous cases that cotton had been ginned in the morning, stuffed into containers at noon and loaded on the vessel in the evening.
6. Most important both crops are GMO free since in contrast with the majority of the cotton producing countries in the world, European Union does not permit the use of Genetically Modified varieties for cotton planting.

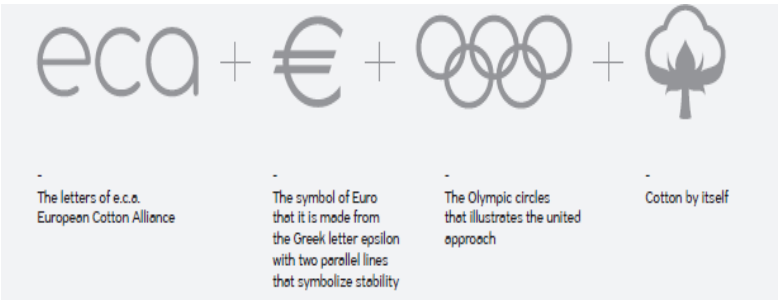


INTANGIBLE ASSETS OF EUROPEAN COTTON

As far as the way cotton is produced,

1. No matter where the production is carried out, (Greece or Spain), it is made according to EU Directives and Regulations of the Common Agricultural Policy (CAP) that reinforce the implementation of sustainable production techniques beneficial for the climate and the environment. According to the cross-compliance and greening standards there are obligations for the farmers, for use of water, biodiversity, good agricultural & environmental condition of land, public health and protection of the farmers and the consumers, crop diversification (=at least two different crops on the farmer's arable land each year) and establishment of ecological focus areas.
2. In addition to that, both in Greece and in Spain, a large percentage of the production is carried out through National Quality Certification schemes that can be defined as standard systems of production that achieve rational use of resources (water, fertilizers, etc), pest management control (IPM programs), traceability and laboratory controls of products.
3. Moreover, since cotton produced in Europe comes from non-GMO seeds and is carried out through National Quality certification schemes that include integrated pest management practices (IPM), it meets the EU regulations of establishing the ecological criteria for the award of the EU Ecolabel for the textile products.

EUCOTTON™ has been developed with the view of incorporating the above stated identity values to a single emblem, that will also combine the European idea of stability and joint work.



The essence behind the EUCOTTON™ is in one hand, its high quality that attracts good demand from the international markets and on the other, its high standards of production, according to the European Common Agricultural Policy (CAP) strict regulations, that ensure good levels of environmental and social performance.

The licensing programs

In September 2019 commenced the process of registering the Collective Trademark to EUIPO, the European Union Intellectual Property Office responsible for managing the EU trademarks and the registered Community designs. Among other formalities, the guidelines of the regulation that describes the conditions of use of the registered trademark decided to be in accordance with the following principles:

- Cotton has to be produced from NON GMO seeds
- Cotton production has to be carried out in the border of European Union in compliance with the environmental and sustainable standards of the EU Common Agricultural Policy (CAP)
- Cotton has to be processed by Firms that are registered in EU, operating under the European Law, and are in compliance with the labor and environmental rules applied in the European Union

The idea is, the Organization to grand the right of using the registered EUCOTTON™ to the members of the Alliance, that manage to produce cotton in accordance with the conditions of the submitted regulation. From this running season we are optimist that a large part of the bales produced in the European Union will bear the Tag of the European Cotton Alliance and the EUCOTTON™, as an extra feature of its standard quality that will always be the critical factor for initiating the business.

Of course, the view is the licensing program to be extended further to the supply chain. ECA is currently examining to launch a traceability scheme where products made with licensed European Cotton will be allowed to bear an "EUCOTTON™" quality trademark. The quality indication will be addressed to the textile chains and retailers and is expected to increase demand in products made with European cotton.

BCI Agreement

Moreover, as part of the continuous evaluation of the sustainable production methods adopted in Europe, the Greek National Quality certification scheme AGRO 2, developed by the Hellenic Agricultural Organization ELGO-Demeter, harmonized with BCI (Better Cotton Initiative) protocol so that, the cotton certified with the AGRO 2 protocol, that is obviously a percentage of the produced EUCOTTON™, will be sold as Better Cotton to BCI members. Spain is on the way to follow.

The European Cotton Sector

As it may inferred EUCOTTON is not another identity cotton producing program. It is rather a systematic approach to communicate the identity values of a sector that works efficiently and looks for improving its performance constantly. Europe is not a volume trader since cotton produced in European Union accounts only 2% of the world total. However, European crop is especially important to the world cotton trade. Europe ranks at the first ten positions of the major cotton exporters. Moreover, the EU cotton sector, although a small sector in the European Union accounting only a small portion of the total agricultural expenditures, is extremely important for the regions where cotton is produced. In the producing countries there is a long tradition in cotton farming and processing accompanied with large investments and an extensive knowhow in cultivation practices and high level of professionalism at the industry and trade. The sector was achieving good performance through exports, due to its high quality, even during the period that the EU textile industry was shrinking because of the competition with lower producing cost countries

Recent trends & developments

As far as it concerns the trends and the recent developments of the industry and the consumers buying attitudes, it is pointed out that: European textile companies and large international textile mills are straight influenced by their cooperation with multinational brands. A core issue for them lays on the sourcing of sustainable raw materials. Worthwhile mentioning that, Sustainability, including Transparency and Traceability, increasingly grows in importance for retailers and brands that consistently demand for cotton produced with social and environmental standards. The

issue of sustainability in textile products is also a prominent issue in the minds of demanding European, or international shoppers. These consumers are increasingly demanding information on the origin and history of the products, putting pressure on retailers to provide transparency. They pay a lot of attention to environmental and sustainability issues of the raw materials used for the production of the textile goods, while, they perceive products manufactured in Europe or from European raw materials as top quality counting a lot to the regulations in place from the European Union. This trend is estimated that will gain momentum at the time of the pandemic since consumers are more cautious for the quality and the safety of the products they consume.

At this environment it is admitted that the European cotton could perfectly match the special requirements of the industry that looks for better serving the appearing consumer's needs.

EUCOTTON
EUROPEAN COTTON ALLIANCE

Conclusion

As a conclusion, I want to point out that EUCOTTON is the Collective Trademark of the European cotton sector that incorporates all the identity features of a product that attracts good demand from the international markets and achieve high level of environmental and social performance. This is the true story of our product that we want to share with our customers, the European and International textile manufacturers, and the international merchants, who can encompass these values to their products and practices.

Our vision is to work closely with the Textile Chain, all the way up to the retailers and the consumers, to recognize our product as a high value, sustainable source material used for the production of high value, end textile products. The target should be to build values for the European and International Textile Industry that looks for better serving the special needs of the demanded European and International consumers. The consumers that might appreciate end products manufactured in Europe, or from European raw materials that match the criteria regarding the quality (transparency and traceability), the environment & the society.

Our slogan of the campaign launched and directed by the European Cotton Alliance is that the European Cotton is of

"High quality - Responsible produced- Grown from NON-GMO seeds"

Cotton Breeding in Greece

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Cotton constitutes a product of strategic importance for Greece. The Greek historian Herodotus (485-425 B.C.) was the first of the ancient Greek writers who mentioned cotton in India and described cotton as “wool from wood”. It appears that cotton became known to Greek people with the expedition of Alexander the Great in India, around 325 B.C., although the earliest information on cotton cultivation in Greece comes from Pausanias, a Greek topographical writer and traveller of the 2nd century A.D., who calls cotton 'byssus', and the cotton fabrics “byssina”. The name cotton it appears in 6th century AD and till the 10th century it spread throughout Greece (Christidis, 1965).
Dr. B. Christidis, the establisher and first Director of Cotton Research Institute (CRI), in 1932, was firstly initiated to identify productive and desirable genotypes among the local mixtures cultivated.

Through the passing of years the main objectives of the CRI were the breeding of improved cotton varieties, more adapted to local conditions, the study and application of more appropriate cultural methods and the investigation of any factor affecting yield and quality in order to contribute to development of cotton cultivation in Greece.

CRI equipped with high qualified staff, and with up-to-date testing laboratories, was carrying out numerous variety trials in various growing areas in order to determine the most suitable cotton varieties for Greece and also involved in multiplication and cotton seed propagation in order farmers to use only certified seeds.

environment. According to the cross compliance and greening standards there are obligations for the farmers for proper use of water, to maintain biodiversity and the good agricultural condition of land, take care of public health and protection of farmers and consumers. At least two different crops have to be cultivated on the farmer’s arable land each year in order to keep crop diversification and is predicted the establishment of ecological focus areas.

Greek cotton growers following the sustainable production techniques and environmental standards through the passing of years gain a very good level of knowledge and experience in all agronomic practices for cotton production. Furthermore, the whole cotton sector in Greece (farmers, ginners, agents and traders) is strongly committed to cotton and cooperate to increase the awareness of cotton identity features to the value chain.

Hellenic Agricultural Organization DEMETER- registered, last years, 16 cotton varieties to Greek National Catalogue and although their low market share, they are the starting material of new advanced lines that tested now to the Institute of Plant Breeding and Genetic Resources (IPBGR).

The recent aims of IPBGR in cotton research are

- Breeding new cotton varieties for earliness, higher yields, disease resistance, advanced quality and better agronomic characteristics.
- Selection of genetic material highly adaptable to the constraints due to climate change, especially in Mediterranean area.
- Incorporation of alternative novel management practices in cotton cultivation that increase water and fertilizer use efficiencies for under projected future climate changes in the Mediterranean basin.
- Optimization of cultivation techniques and adoption of cotton conservation tillage where the majority of land for many years was under conventional tillage and monoculture.
- Improve cotton crop management in Mediterranean area and enhance the sustainability of agro-ecosystems with the use of locally adapted covered crops or covered crop mixtures.

Greek AGRO-2 Integrated Management Standards and BCI

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Integrated Management is an alternative, environmental-friendly method in agricultural production, promoting the sustainable use of inputs and agricultural practices implemented. This approach ensures that certain product properties or production method characteristics are met, in accordance with mutually accepted and identifiable specifications-standards. Although volunteering, Integrated Management is highly significant for modern Greek agriculture, contributing to the competitive advantages of local commodities. Recognizing its added value, several agricultural holdings have already enrolled to this scheme, acquiring the appropriate national certification mark, strengthening their products competitiveness and guarantying custody chain related information (traceability) for the consumers.

The Hellenic Agricultural Organization, namely ELGO-DIMITRA, a statutory body under the Greek Ministry of Rural Development and Food responsible for the development of specifications/standards in the agri-food sector, has issued the AGRO-2 Integrated Management Standards. The overall goal is: 1) to promote integrated management of agricultural holdings, 2) to reduce inputs and protect the environment, and 3) achieve the best possible financial outcome for farmers. ELGO-DIMITRA has also developed a comprehensive state-of-the-art information system, namely i-AGRO. Its development, use, and constant upgrade has improved the supervision of the certification chain, through the continuous monitoring of measurable results and the implementation of targeted interventions.

ELGO-DIMITRA and the Inter-Branch Organization of Greek Cotton (DOV) (henceforth, jointly ELGO-DOV) have submitted the AGRO-2 standards to a comprehensive gap analysis and benchmarking process against the Better Cotton principles, as defined by the Better Cotton Initiative (BCI).

BCI is an independent international non-profit organization established in 2009, constituting today the most important program of sustainable cotton cultivation worldwide. The producers enrolled in the program are trained in managing irrigation water efficiently, reducing pesticide use, preserving soil health, protecting the ecosystem and enhancing biodiversity, minimizing the impact of harmful agricultural practices, limiting greenhouse gas emissions towards climate resilience, reassuring fiber quality, and implementing the 'Decent Work' principles (e.g., protect fundamental human rights; employee rights regarding safe working and pay, etc.). Therefore, BCI is a holistic approach to cotton cultivation, supporting all three pillars of sustainability, namely the society, the economy, and the environment. The system is designed to cash in the implementation of Good Agricultural Practices and encourage the escalation of collective action of its members/stakeholders towards establishing cotton as a dominant sustainable commodity.

In October 2020, after the benchmarking process completion, Better Cotton and ELGO-DOV became Strategic Partners, recognizing the Greek AGRO-2 Integrated Management Standards as equivalent to the Better Cotton standard system. Following this historic landmark for Greek Cotton production, several Agricultural Holdings and Ginners have enrolled in the AGRO-2 certification, encompassing a noteworthy number of hectares planted/ farmers /ginning factories involved (made eligible to sell their cotton as Better Cotton henceforth). Considering the venture's added value, it is estimated that the number of farmers growing AGRO-2 licensed cotton (equivalent to Better Cotton) will be increasing significantly from one year to the next.

It must be underlined that famous international brands have already expressed interest in Greek cotton certified according to the AGRO 2-BCI standards, a fact that emphasizes the new prospects deriving from the promotion of certified products in high demand markets, and, by extension, the importance of practicing – and being certified for – Integrated Management.

ΥΠΟΥΡΓΕΙΟ ΑΓΡΟΤΙΚΗΣ ΑΝΑΠΤΥΞΗΣ ΚΑΙ ΤΡΟΦΙΜΩΝ
ΕΛΛΗΝΙΚΟΣ ΓΕΩΡΓΙΚΟΣ ΟΡΓΑΝΙΣΜΟΣ "ΔΗΜΗΤΡΑ"

BCI Better Cotton Initiative

Abiotic Stress Tolerance in Cotton Through Genome Editing: Challenges and Opportunities

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Abstract

Targeting genomes with higher specificity and fidelity has been become possible with the emergence of genome editing (GenEd) tools. Artificially engineered nucleases (ENs) and proteins such as zinc finger nuclease (ZFNs), transcription activator-like effectors nuclease (TALENs) and clustered regularly interspaced short palindromic repeats (CRISPR) RNA-guided nucleases (e.g., Cas9) are the most prevalent and frequently used GenEd tools. ZFNs, TALENs and CRISPR/Cas9 are used to produce double-strand break (DSB) at the predefined target sequence which is subsequently repaired through non-homologous end joining (NHEJ) or homologous recombination (HR). Different animal and plant species have been genetically modified using GenEd tools. In case of plants, Arabidopsis, tobacco, tomato, rice, wheat, soybean, potato, maize etc. have been successfully targeted with GenEd tool. After successful application of GenEd tools in a number of plant species, efficient methods have been developed for genome editing in cotton. Fast methods to evaluate gRNAs through transient expression in cotton have been optimized along with stable transformation of CRISPR/Cas9. GenEd tools can be used for several purposes such as genetic improvement of cotton against abiotic and biotic stresses, increasing growth, yield and fiber quality, and modulation of regulation of gene expression on genomic and epigenetic level. This review encompasses application GenEd tools for improvement of cotton with special emphasis on challenges and opportunities.

Key words*: *ZFNs, TALENs, CRISPR/Cas9, Cotton, Targeted genome modifications

Introduction

Cotton is a multifaceted problem crop encountered with numbers of biotic and abiotic stresses from germination to harvest. Climate change has become another havoc for cotton that has put it in threat of unfavored environment. Prolonged heat, cold and unexpected rains change the insect and disease dynamics. It also changes the scenario of abiotic factors like soil composition effecting the soil web, causing drought, salinity, and water scarcity (Onyekachi et al., 2019). All these factors integrate to make cotton as less profitable crop discouraging the farmers to grow it. But cotton deserves more value as it is the only a spinnable natural fiber crop and a pivotal commodity of the world economy (Janzen et al., 2018). A systematic and profitable production system is required to address all the problems and make cotton as a profitable crop keeping in view the sustainable development goals set by United Nations (UN).

Genome editing has revolutionized the field of biotechnology and genetic engineering in plants and animals with equal success. Every researcher is well familiar with genome editing and using this marvelous technology in their fields to get precise genetic modifications. Precise genetic engineering has been a longstanding fundamental goal of scientists doing research in the field of synthetic biology, gene therapy, drug

development, molecular breeding and biotechnology. Researchers are using ENs; ZFNs, TALENs, meganucleases, CRISPR/Cas etc., from last couple of decades to recruit repairing machinery of the cell by creation of DSBs at predefined target sites. GenEd technique has been found fruitful in plants and animals with equal success to provide sites and genes specific targeted mutagenesis. From eukaryotic to prokaryotic organisms, GenEd tools were found marvelous in precise genome editing for different purposes. A variety of organisms have been genetically engineered for targeted genome editing using GenEd tools. Advancement in genome editing technology like base and prime editing has emerged as promising with more precision and minimize the chance of off-targets (Mishra et al., 2020). Prime editing has been reported in rice and wheat while base editing in cotton, maize and wheat.

All ENs produce DSBs at the target site in the DNA sequence followed by repairing the cellular machinery with or without errors using non-homologous end joining (NHEJ) or homology directed (HDR) repair pathways (Puchta et al. 1996; Puchta 1998; Bibikova et al. 2001). NHEJ and HDR are used for gene repair, replacement of faulty genes and insertion of new one (Zhang et al., 2013). CRISPR-based genome editing can be employed to edit a gene as well as a metabolic pathway. Genome editing through CRISPR has achieved another milestone in the form of multiplexing which can be used to edit 6-8 genes simultaneously (Bortesi et al., 2015). So, breeders involved in the development of a variety with the multigene character can use multiplexing technology to get high accuracy and efficiency.

Using GenEd Tools for Cotton Improvement against Abiotic Stresses

Understanding molecular mechanisms and basis of abiotic stresses including salinity, drought, and heat along with their tolerance mechanisms is very important to engineer stress tolerance in plants. To increase the tolerance in cotton against drought stress, transcription factors are excellent candidates for the plant scientists. Various transcription factors such as MYB, WRKY, ERF, NAC, bZIP are involved in normal development as well as in drought stress response. These transcription factors have been cloned and proven useful for stress tolerance in cotton and/or in other plants. The genetic engineering of transcription factor genes could activate drought tolerance pathways and enhance drought tolerance in cotton. Recently, a bZIP transcription factor gene, GhABF2, has been reported in the drought and salt tolerance in Arabidopsis and cotton. The transcriptomic analysis revealed that GhABF2- regulate genes related to ABA. Overexpressing GhABF2 in cotton increased SOD and CAT activities as compared to wild-type plants. Moreover, overexpressed plants showed better results in the field and meanwhile its yield were recorded higher than wild type plants (Liang et al. 2016). Efficient stacking of these transcription factors/genes in elite cotton varieties under strong promoters could be helpful in producing tolerance against abiotic stresses in plants. It has been reported that overexpression of GbMYB5 is positively involved in response against drought stress in tobacco and cotton by reducing water loss through stomata and showing hypersensitivity to abscisic acid (ABA) (Chen et al. 2015). In another study, it is observed that VIGS-mediated gene silencing of sucrose non-fermenting1-related protein kinase2 (GhSnRK2) resulted in mitigated drought tolerance in cotton plants indicating that GhSnRPK2 positively involved in drought stress and low temperature tolerance in plants (Bello et al. 2014). Furthermore, silencing of cotton PHYA1 genes through RNAi increased photosynthesis and improved root systems in plant resulting in drought, heat and salt tolerance (Abdurakhmonov et al. 2014). Similarly, there

are many genes such as GhPIN1-3 and GhRDL1 that can be targeted for drought tolerance in cotton (He et al., 2017; Dass et al., 2017). Many genes of transporters, transcription factors and different enzymes such as CIPK, MYB, NAC, LEA, WD40, CDPK and NHX have been reported for reported for salt tolerance in cotton (Sun et al., 2018). There are some genes such as IAR3, FPGS3 and two ESTs (GhHS126 and GhHS128) which were reported for heat tolerance in cotton (Demirel et al., 2014). GenEd tools may be used efficiently to mutate or suppress gene at transcriptional level. Multiple genes of gene families may also be targeted using multiplex CRISPR system.

Many reports have been found in other plants where genome editing was used to improve abiotic stress tolerance in candidate plant. CRISPR/Cas9 system was utilized to generate SIMAPK3 mutants to study drought stress in plants (Wang et al. 2017). It was observed that transgenic maize plants with reduced ethylene biosynthesis by silencing 1-aminocyclopropane-1-carboxylic acid synthase 6 significantly improved grain yield under drought stress conditions (Habben et al. 2014). Similarly, decreasing the sensitivity of maize to ethylene also resulted in higher yield (Shi et al. 2015). Overexpression of ARGOS genes, negative regulators of the ethylene response enhance drought tolerance in transgenic maize plants (Shi et al. 2015; Guo et al. 2014). Mutation produced through CRISPR-Cas9 in OsDST gene of rice increased the salt and drought tolerance by increasing the width of leaf and reduction in stomatal density (Kumar et al., 2020). Various genes involved in stress regulatory network, signal transduction and metabolite production may be simultaneously targeted via CRISPR-Cas9 Multiplex genome editing technologies for engineering stress tolerance in crop plants. An additional strategy could be pyramiding/stacking of multiple stress regulatory genes through HDR-mediated gene targeting. Technology advancements such as base editing in CRISPR Cas9 technology opens new endeavors of abiotic stress tolerance in plants through précised point mutation (Mishra et al., 2020). In rice, the tolerance against submergence is switched through a cytosine base-editor by altering the C>T in Sub1A gene (Bhowmik et al., 2019). Similarly, prime editing has capability of precise and efficient gene editing in plants (Marzec, 2020). Different genes discussed above coupled with different promising genome editing techniques can be used to equip the cotton crop with abiotic resistance/tolerance traits. Different applications of GenEd tools for genetic improvement of cotton is shown in Fig. 1.

Future perspectives

The flexibility of using different engineered proteins and nuclease to get desirable and precise results has increased the canvas of applicability of genome editing tools. Scientists are working on the understanding and nature of genome editing tools to address limitations associated with the usage of these tools. The most important limitation is the off-targeting. To address off-targeting, one can choose a different tool from the toolbox. Researchers have found that TALENs, having a long target site, have fewer off targets compared to ZFNs and CRISPR/Cas. Regarding regulation and acceptance of genome edited organisms (GEOs), USDA has announced no regulation for ENs-based precise deletions in the genome. This development has been found very encouraging for the scientists which are working in this field. Many crop plants and animals have been targeted with ENs or artificial DNA binding proteins and promising results have been found. The variety is increasing in the GenEd toolbox which further broaden the scope and applications of genome editing. Suppression of gene at DNA level by creating deletions/insertions in the target DNA has been proved more

fascinating than previously developed technologies such as RNAi. Mutations created by GenEd tools are more precise, specific and efficient with predictable results while other techniques e.g. RNAi, TILLING and use of other mutagens do not have these features. Moreover, tunable and remote-control regulation of gene expression has become possible using GenEd tools. Expression of indigenous genes can be regulated efficiently using TALEs, ZFs and dCas alone or fused with effector domains. Researchers have also found that after transformation of GenEd reagents, further generations of the transgenic plants can be produced free of these proteins through segregation.

So, these tools can also be used for production of transgene free plants and for clean gene technology as well. Scientists and researchers working in the field of genome editing are very enthusiastic and optimistic about the bright feature of this field. All field of biology are now using these tools to produce desirable genetic improvements in plants and animals.

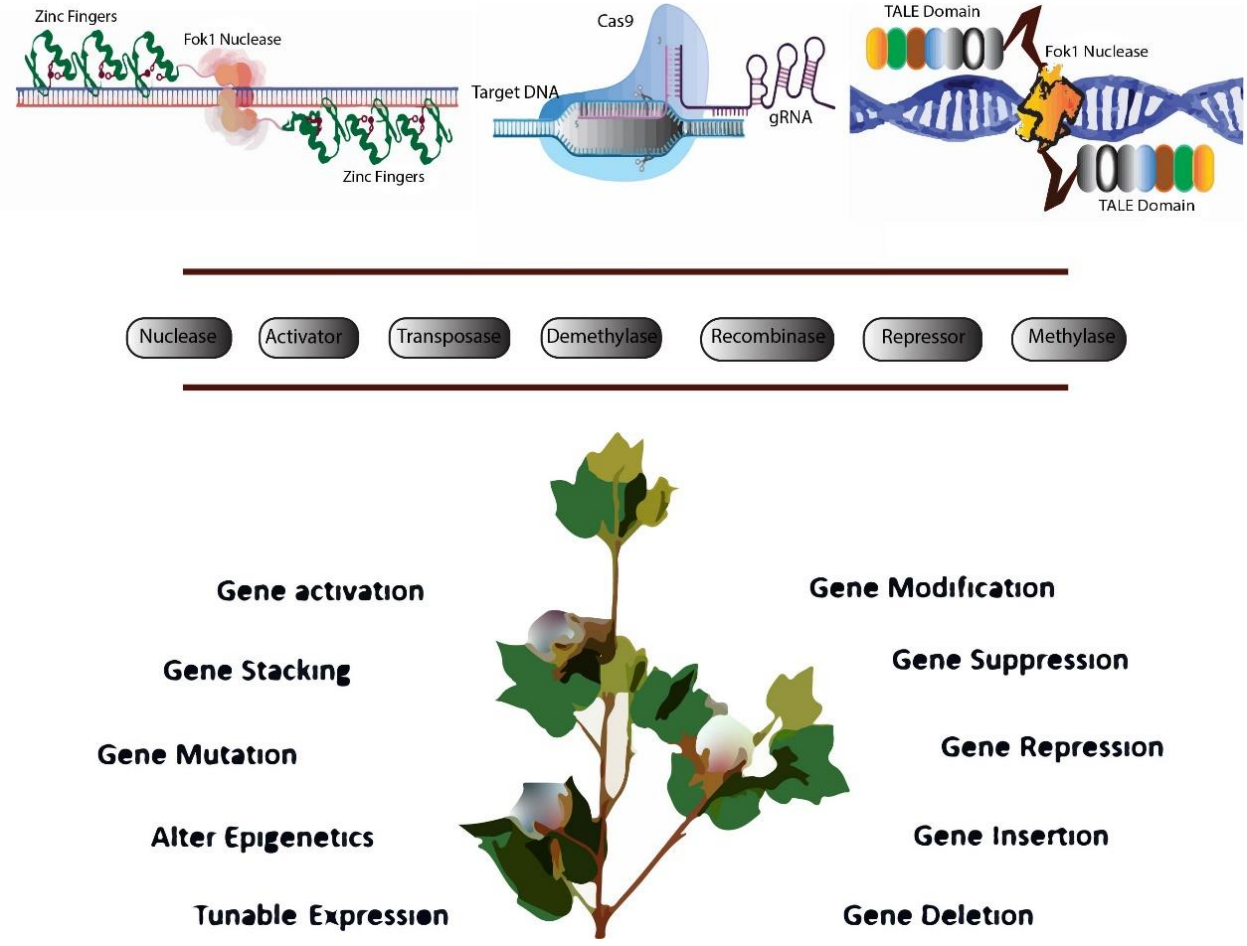

Fig. 1: Applications of genome editing tools for cotton improvement.

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LD 949 - A High Yielding Variety of Desi Cotton

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In this note, salient features of LD 949 - a *desi* cotton (*G. arboreum*) variety developed by Punjab Agricultural University, Ludhiana (Punjab), India are being presented. LD 949 has been developed through initial hybridization of LD 327 × HD 263 followed by pedigree method. LD 327 is a *desi* cotton variety developed by Punjab Agricultural University, Ludhiana and released for general cultivation in the Punjab state in 1987. In turn, LD 327 has been developed through the cross between G 57 × (G 27 × LD 124) followed by pedigree selection method, whereas, HD 263 is an advance culture of *desi* cotton developed by Department of Plant Breeding, CCS Haryana Agricultural University, Hisar (Haryana). Plants of LD 949 are pigmented (red), tall with digitate leaves possessing five lobes. Flower petals are variegated, and petal spot is present. Nectaries and gossypol glands are present on leaves. LD 949 bears open, red coloured medium sized ovate bolls having pitted surface and pointed tip and has solitary boll bearing habit. Bracts are normal with serrations. Its plant growth habit is indeterminate and it matures in about 160 days. Seed index (100-seed weight) ranges from 5.7 through 6.7 g.

LD 949 is resistant to bacterial blight, moderately resistant to *Fusarium* wilt and moderately susceptible to fungal foliar leaf spots. It is tolerant to jassid (leaf hopper) and whitefly. LD 949 registered jassid injury grade of I and 1.17 jassids/3 leaves. Similarly, it recorded an average whitefly count of 3.73 /3 leaves. LD 949 is tolerant to salinity. This cultivar possesses short, coarse and white fibre. It recorded an average 2.5% span length of 20.6 mm, micronaire value of 7.0 and fibre strength of 17.3 g/tex. Lint of LD 949 is suitable as absorbent cotton.

On the basis of 18 trials conducted in three years across the North Indian cotton growing states, LD 949 produced an average seed cotton yield of 2479 kg ha^{-1}, average lint yield of 874 kg ha^{-1}, and lint percentage of 39.2%. Recommended seed rate for LD 949 is 7.5 kg ha^{-1}. Planting should be done in lines 67.5 cm apart with cotton sowing drill or cotton planter. The plants within rows are to be kept 45.0 cm apart at thinning. LD 949 has been recommended for cultivation in Punjab, Haryana, and Rajasthan under irrigated conditions. It has been assigned a national identity number IC 611880 by ICAR-National Bureau of Plant Genetic Resources, New Delhi.