



Report on Study Visit to USA on High Density Cotton Cultivation and Farm Mechanisation in Texas, Tennessee and Missouri States of USA

(June 30- July 10, 2022)



Submitted by:

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MINISTRY OF AGRICULTURE, COOPERATION AND MARKETING

Government of Telangana, Hyderabad.

Introduction

Cotton is the leading and most important fiber crop being cultivated in more than 25 countries in the tropical and subtropical parts of the world. In certain countries, it is recognized as “white gold” as it is globally traded commodity and earns huge foreign exchange. In the world, cotton fiber is a distinguished fiber that serves as a raw material for textile industries having an annual economic impact of about \$600 billion.

In the year 2021-22, about 24 million tons of (approx. 135 million bales) cotton is being produced around the globe as against the annual average of 25-26 million tons annually with the global average productivity of 775 kg/ha. Top ten cotton-producing countries are India, China, the United States, Pakistan, Brazil, Australia, Uzbekistan, Turkey, Turkmenistan, and Burkina Faso. India is the largest producer of cotton in the world, produces about 6.2 million tons of (35.2 million bales) cotton per year, followed by China produces about 6.1 million tons of (34.6 million bales) cotton per year and the United States with an annual production of about 3.6 million tons of (20.4 million bales) cotton.

In India, cotton plays a dominant role in the industrial and agricultural economy of the country. It provides direct livelihood to 6 million farmers and about 40 -50 million people are employed in cotton trade and its processing industry. There are ten major cotton growing states namely, Punjab, Haryana, Rajasthan, Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh, Telangana, Karnataka and Tamil Nadu. Besides these ten States, cotton cultivation has gained momentum in the Eastern States like Orissa, Chhattisgarh, Tripura West Bengal etc.

India cultivates cotton (more than 95 % is Bt cotton) in an about 13 million hectares annually, more than one third of the World's area (about 33 million ha per year) under cotton with a productivity of about 480 kg/ha, which is far below than the World's productivity of 775 kg/ha. Maharashtra, Telangana and Gujarat are the leading States, nearly 70 percent of the crop is cultivated under rainfed condition in the Central and Southern regions of the country. Among the cotton producing states, Maharashtra is the largest producer with an area of 42.25 lakh ha followed by Telangana (24.13 lakh ha) and Gujarat (22.79 lakh ha) (2020-21).

In Telangana, agriculture plays a pivotal role in the economy of State and improvement in the performance of this sector is vital for inclusive growth. Vanakalam and Yasangi seasons put together, Telangana is having a cultivated area of 83.60 Lakh hectares (209 Lakh acres) and grows more than 20 important crops. The major crops grown are Paddy (42.40 Lakh ha), followed by the Cotton (24.2 Lakh ha), Redgram (4.3 Lakh ha), Maize (2.7 Lakh ha), Soybean (1.6 Lakh ha), Bengalgram (1.4 Lakh ha), Groundnut (1.2 Lakh ha), Jowar (0.9 Lakh ha) etc. Government of Telangana is promoting crop diversification to ensure sustainability of agriculture in the State. Cotton is the second major crop and has been cultivating in area of about 24 to 25 Lakh hectares (60 to 62 Lakh acres) annually and this has been increasing year after year.

Cotton is being cultivated in all most all the 32 districts and the major districts are, Adilabad, Nalgonda, Medak, Asifabad, Mancherial, Nirmal, Rajanna-Sircilla, Sangareddy etc. Telangana, though it is second in the country with respect to cultivated area, it is largest producer of cotton in the country with a productivity of 546 Kg/ha, which is higher than the national average of 480 Kg/ha. Further, the cotton produced in the State has been already recognised by the Cotton Corporation of India (CCI) as a top-quality product in the country as well as international market. The government is planning to provide more incentives to the ginning mills in addition to the supply of subsidised power presently for encouraging cotton cultivation in the State. Since 2014-15, the number of ginning mills has gone up from less than 100 to nearly 350 ginning mills at present; few more mills are under construction. The number of ginning mills is expected to increase further, due to increased cotton production.

Thus, Telangana is one of the major Cotton producing states in the country. Therefore, need to increase the production, productivity and farmers income by effectively harnessing the benefits from the new technologies coupled with suitable Agro-Climatic conditions. Increased cost of cultivation, higher seed cost, weeds & pest problems, labour shortage, yields stagnation, lint quality issues, no mechanisation etc. are the main reasons that are hindering the growth of cotton industry and farmers in the State. Considering the duration, cost involved in manual harvesting etc., farmers were looking for alternate options like genotypes that could yield better under higher planting densities with fewer bolls per plant, synchronized maturity with uniform bursting. These gaps necessitate progressing further in the yield front of cotton provided newer technologies and cropping systems like High Density Planting System (HDPS) and mechanisation in the cotton farming practices.

In this direction, in order to address these gaps, the Government of Telangana is planning and supporting the research, development and large-scale demonstration of high-density cotton cultivation (HDPS) and farm mechanisation in the State for the benefit of cotton farmers and to encourage cotton cultivation in the State.

The farm mechanisation is one of the flagship programmes of the Government of Telangana and planning to promote high density cotton cultivation under highest possible mechanisation for the benefit of farmers. The Government has already been carrying out trials in an area of about 20,000 acres in 13 potential cotton growing districts through the private Seed companies and the Professor Jaishankar Telangana State Agril. University to promote high density cotton cultivation under mechanisation. Major requirements for the mechanisation of cotton cultivation are availability of suitable genotypes, precision crop management technique, machineries like planters, pickers, and appropriate chemical growth regulators. In this direction, the USA has been adopted well established mechanised cotton cultivation since long time and the cotton farmers of USA has been harnessing the benefits in terms of improved yields, exports and higher incomes.

With the above context, the Hon'ble Chief Minister has constituted a team of delegation (G.O. Rt. No. 291 of the Agril. & Coop. (Agri) Dept., dated 27.06.2022) under the leadership of the Hon'ble Minister for Agriculture, Cooperation & Marketing, Government of Telangana, who have proceeded to the USA for studying high density cotton cultivation practices and farm mechanization in Texas, Tennessee and Missouri States of USA from 30.06.2022 to 10.07.2022 with the following members;

- Shri Methuku Anand, Member of Telangana Legislative Assembly (Vikarabad Constituency)
- Shri Peddi Sudarshan Reddy, Member of Telangana Legislative Assembly (Warangal -Rural Constituency)
- Shri Ramavath Ravindra Kumar, Member of Telangana Legislative Assembly (Devarakonda Constituency).
- Dr. K. Keshavulu, Managing Director, Telangana State Seed Certification Authority and Seeds Development Corporation and President of International Seed Testing Association (ISTA)

Visit to research facilities and cotton production fields of Bayer Crop Science at Missouri State, USA on 5 July, 2022

Telangana delegation headed by the Hon'ble Minister of Agriculture, Co-operation and Marketing, Government of Telangana visited research facilities and cotton production fields of Bayer Crop Science at St. Louis, USA on 5 July, 2022.

In St. Louis, Missouri State, all the cultivated cotton is upland GMO cotton and interestingly all are open pollinated varieties with dwarf stature suitable for rainfed conditions and following high density planting system with a population of 75,000 to 1,00,000 plants per hectare under completely mechanised farming from the planting to harvesting, where planting is done by planters, weed and pest control by chemicals also GM crop varieties, harvesting by cotton pickers with appropriate usage of defoliants and getting an average yield of 800 to 900 Kg per ha.

Bayer Crop Science is German based multinational company having 150 years of history in helping to improve the livelihoods of millions of farmers and supporting food security around the world. It is a dedicated global farm inputs company and leading the innovations in global agriculture and supporting the livelihood of 100 million small holder farmers across the globe including India and striving to deliver sustainable solutions to the farmers through wide range of product portfolio such as, crop protection chemicals, innovative traits, seeds and digital solutions. It is also a pioneer company in the cotton research and innovative traits development to maximise the cotton yield and income to the farmers.



The Hon'ble Minister and the delegation at Bayer Crop Science, St. Louis, Missouri State



Telangana delegation at research facilities of Bayer Crop Science in St. Louis, Missouri State

Bayer provides a range product that can contribute to the efficient and profitable management of cotton crops. The Bayer having advanced research facilities and developed innovative cotton traits through CRISPR technology, and presently providing 3rd generation Bt cotton varieties i.e. Bollgard® 3 and Roundup Ready Flex®, which provides the growers with superior insect and weed control, enabling higher yields and cleaner fields, in addition the 4th generation cotton varieties are under pipeline. Further, it has also developed a defoliant Dropp® UltraMAX™ for high density cotton cultivation; other products include insecticidal seed treatments, growth regulators and insecticides that give the flexibility to manage regular challenges using different modes of action in cotton cultivation.

During the interaction with Bayer Crop Science Scientists, it was discussed that the Bayer Crop Science has been developing high yielding varieties/hybrid varieties of cotton, hybrids of maize and vegetables for cotton growing countries. The company is having MoUs with different countries on cotton germplasm sharing for developing suitable genotypes for HDPS, and has been trying to develop varieties for India. Therefore, Telangana State is important and interested to have need-based collaboration with the Government of Telangana on cotton research aspects.



Telangana delegation interacting with management authorities of Bayer Crop Science at St. Louis, Missouri State

Visit to research facilities and cotton production fields of BASF at Memphis, Tennessee, USA on 6 July, 2022

The Hon'ble Minister of Agriculture, Co-operation & Marketing and delegation had visited the facilities of BASF and cotton fields in Memphis, Tennessee, USA on 6 July, 2022.



Visit to Cotton fields at Memphis, Tennessee State

Tennessee State annually produces about 550,000-650,000 acres of cotton with average lint yields range from 300 to 400 Kg of lint per acre. Cotton is produced in 23 counties state wide, with the majority grown under rainfed conditions with suitable drought resistance dwarf genotypes in the western part of the state. However, limited acres are grown under irrigation. Tennessee state has long been a proponent of conservation and no-tillage systems, with approximately 52 percent of the cotton grown on no-till and an additional 24 percent grown using some form of conservation tillage.

Cotton variety tests are conducted each year at multiple locations in Tennessee to obtain performance information, which is then used to assist the producer in selecting varieties to grow. Lint yield is the most important consideration in selecting a variety. Increased emphasis is being placed on fiber strength, length, length uniformity and micronaire.

During the visit, Hon'ble Minister of Agriculture interacted with a farmer Mr. Micheal Watkins, who owns 23,000 acres of land, of which 13,000 acres has been cultivated under cotton. Interestingly, he owns planters, cotton pickers, and ginning mills and also pre-cleaning machinery at farm level for pre-cleaning of cotton at farm level. The average land holding size was found to be 1000 to 5000 ha.



Hon'ble Minister along with Telangana delegation interacting with Cotton Farmer at Memphis, Tennessee State

Tennessee State is also known for cotton seed production and it is the largest exporter (90 % of the produced cotton) of cotton in USA. Mainly upland and mid land cotton cultivation is being done entirely under mechanised system with good quality lint production (both short and long staple cotton). A planter can do planting in an area of 100 to 150 acres per day and a cotton picker (Cost-1 million USD) can pick 50 to 70ha per day with reasonably good quality lint with very less contamination.



(a) Cotton planter used in Tennessee State, USA



(b) Cotton picker used in Tennessee State, USA

BASF-USA as an industry leader with a broad portfolio of fungicides, insecticides, herbicides and seed treatments, BASF helps farmers to sustainably increase the yields and the quality of their crops. By nurturing a culture of innovation in alignment with customers' needs, BASF technologies aim to ensure that crops grow healthier, stronger and more resistant to stress factors, such as heat or drought. The company has been investing on research and development to underpin a broad portfolio of Agri-chemicals, development of varieties with suitable traits, seed treatment products and digital solutions.

FiberMax® Cotton from BASF developed to deliver superior fiber quality even in the roughest growing conditions, FiberMax cotton seed is specifically made to stand up to the meanest weather, nematode, insect and disease pressures in the Cotton growing belts of USA with the help of modern germplasm, ground-breaking breeding tools and techniques that introduce regionally relevant characteristics into cotton varieties.

Visit to research facilities of Texas A & M University and UPL-Advanta Seeds at Houston, Texas, USA on 7 July, 2022

Telangana delegation under the leadership of the Hon'ble Minister of Agriculture, Co-operation and Marketing, Government of Telangana visited research facilities of Texas A & M University and UPL-Advanta Seeds and cotton production fields at Houston, Texas, USA on 7 July, 2022.

Texas ranks first in cotton production in the U.S. Cotton is the leading cash crop in the State, and is grown in about 5 million acres. This crop generates \$1.6 billion in cash for farmers and has a total economic impact of \$5.2 billion for the State. Texas accounts for approximately one-half of the cotton acres and roughly 40% of the total production in the U.S.

Cotton is grown on five million acres in six different regions, each with different production systems and variations in climate, soil type, rainfall and irrigation, and harvesting techniques. The majority of cotton production occurs through mechanized processes. Tillage, spraying, and harvest are accomplished using motorized equipment usually from an enclosed cab. The majority of irrigated acres in Texas use sprinkler or drip irrigation, requiring very little worker activity in the fields.

Harvesting by cotton picker is being used in all most all the areas with long growing seasons and longer staple cotton. Pickers remove only the seed cotton (fiber and seeds), which results in less trash and good quality lint. Harvest aid chemicals such as desiccants and defoliant are commonly applied prior to harvest. Desiccants are substances intended to artificially accelerate the drying of plant tissue and are used in regions with short growing seasons. Defoliant are applied in picker operations to remove leaves from the mature plant. Plant growth regulators, or boll openers, are used alone or in conjunction with defoliant and/or desiccants to allow more bolls to open prior to harvest. The average yield in Texas State was estimated at 700 to 750 kg per hectare.

Texas A & M University: During the visit interacted with Texas A&M University Scientist Dr. Wayne Smith, Department of Soil & Crop Sciences on University crop research activities. It is the oldest and the first public institution of higher learning in Texas. Texas A&M University is a research-intensive flagship university with dedicated faculty and is one of the largest research universities in the United States. It is providing hands-on research and education to thousands of under-graduate and graduate students on the subjects like medicine, electronics, energy, natural sciences, oceanography etc.



Interaction with Scientists of Texas A&M University

Cotton research has been a major part of the Texas A&M mission as the cotton is the major crop in Texas, it has been delivering technically sound information and providing support to the diverse industry, consisting of growers, consultants, allied industry, governmental agencies, educators, consumers etc.



Visit to Cotton Fields at Texas

University is involved in developing superior germplasm/cultivars which will enhance the productivity and quality, The breeding goals include enhancement of yield and fiber quality potential, and resistance/tolerance to biotic and abiotic stresses. University is also working on the dwarf and compact genotypes suitable for rainfed conditions, usage of defoliants to aid mechanised cotton harvesting etc. The ultimate goal of Texas A & M cotton research and education program is to provide information that supports a healthy and environmentally sound cotton production industry for Texas.

In addition, University is also working on other crops like Soybean, Maize, Sorghum, Millets etc. It also focuses on phonemics studies on maize and sorghum for promoting ethanol production as a substitute for fossil fuels. Other research priorities include drones in agriculture, studies on biology, crop evolution, genomics, or other processes that impact ability to genetically analyse, manipulate and improve plants.

UPL-Advanta Seeds

Interacted with Scientists of UPL-Advanta Seeds at Texas Dr. Ben Bayer, US-Sorghum Breeding Lead and Dr. Raghu Sripathi, Crop Breeder. Advanta is a UPL group company having six decades of research, development and deployment of innovative technologies in delivering high quality seeds to the millions of farmers across the globe including India in wide range of crop portfolios, there by contributing to the improvement of farmers livelihood and sustainable agriculture.



Interaction with Scientist at UPL-Advanta Seeds in Texas, USA

It is sustainable agriculture company with focus on breeding for drought tolerance, disease resistance and higher yields. It is a leading company in USA for forage crops with wide spectrum of forage hybrids in



Telangana delegation at the research facilities of UPL-Advanta Seeds, Texas - USA

Summary

Cotton is a globally important fiber crop that support textile industries around the world. The major cotton producing countries are India, China and USA, among these countries with respect to technologies and mechanisation, USA is ahead of both the countries. India, though a leading producer of cotton in the world, is facing several challenges such as, lower productivity, higher cost of production, 2nd generation Bt. technology, longer duration hybrids, overexploitation of heterosis, yield barriers, labour shortage, low mechanisation, lint quality issues etc. all these together are contributing to the lower income to the cotton growing farmers.

In this background, the United States is best example, wherein farmers are successful in harnessing the better income from the cotton cultivation through the adoption of good cultivation practices, mechanisation, high density planting etc. As a result, the US has emerged as the world's leading cotton exporter, though it ranks third in total production and providing approximately 35 percent of global cotton exports in recent years. Through, its participation in global trade, the United States supports global textile industries and provides opportunities for domestic farmers to market their cotton to the world.

More than 99 percent of the cotton grown in the US is of the Upland variety, with the rest being American Pima. Cotton production is a \$21 billion-per-year industry in the United States, employing over 125,000 people in total. Within the United States, the Southern states traditionally harvest the largest quantities of cotton. The United States produces about 3.6 million tons of cotton per year. The leading cotton producers in the U.S. are Texas, Georgia, Mississippi, Arkansas, Missouri, Tennessee and Alabama and having 700 to 800 Kg per ha. The cultivation practices followed in the States of Texas, Missouri, Tennessee Virginia and Louisiana States are as below;

- **Cotton Varietal status:** In the US predominantly the cotton area is under open pollinated genetically modified varieties belongs to either upland cotton or American pima varieties, which are dwarf, compact, . Whereas, in India more than 95 % of the cotton area is under Bt hybrids.
- **Early maturing cotton varieties:** Variety selection is considered one of the linchpins in cotton management system. New varieties are constantly being released with a unique assortment of traits that may benefit the producer like earliness, hairiness, early season vigour etc.
- **Adoption of next generation GM technology:** USA has adopted 3rd generation GM technology cotton varieties i.e. glyphosate / herbicide tolerant varieties (Bollgard-III) developed through innovative technologies like CRISPR technology. These provides the growers with superior insect and weed control, enabling higher yields and cleaner fields. Further, the 4th generation varieties i.e. cotton varieties resistant to sucking pests along with other novel traits are under pipeline.
- **Cotton genotypes for late planting in cases of natural calamities:** Availability of suitable genotypes for late planting to ensure sustainable yield and quality despite adverse weather conditions.
- **High Density Planting System:** Adoption of high-density planting system with suitable genotypes by increasing plant to 75,000- 1,00,000 per ha with early maturing, compact sympodial plant types and customised agronomic practices, thereby achieving the higher yield of about 30 per cent.
- **Cotton Seed Quality & Germination:** Cotton farmers are well aware of the effect of weak stands on yield and earliness. Skippy, low density stands are generally lower yielding and later maturing, because plant compensation requires time and shifts late boll maturation into unfavourable weather. So, in order to ensure better stand establishment even under adverse conditions, cotton seeds are subjected to various vigour tests like cool test, ammonia toxicity test etc. before selling to the farmers.

- **Agronomic management for good quality lint:** After a variety is selected and seeds are planted, cotton crop is well-managed throughout its entire growing season. Ideally, production decisions like crop nutrition, irrigation, pest management and weed control are matched to the developing crop and weather to maintain a stress-free crop. This system of non-stress production makes healthier plants. Likewise, bolls produced on healthy plants produce longer, stronger and more completely developed mature fiber.
- **Effective Weed Control:** Cotton fields are maintained completely weed free throughout the entire growing period by using herbicides like Glyphosate and adopted BG-III herbicide tolerant cotton varieties.
- **Precision irrigation for cotton yield and lint quality:** Yield and fiber quality are of top priority in cotton cultivation and are influenced by water management. Hence, the precision irrigation techniques are important for consistently higher quality yields. The majority of irrigated acres in USA use sprinkler or drip irrigation, requiring very little worker activity in the fields.
- **Complete farm mechanisation:** Cotton cultivation is completely mechanised from planting to harvesting by using specialized equipment such as, pneumatic planters for sowing, tractor mounted sprayers for chemical sprays, inter-cultivation by tractors, automatic drip /sprinkler irrigations and mechanical cotton pickers for harvesting, then harvested cotton from the field is pressed into round bales or large modules for transport to a gin. During the ginning process, cotton fibers are separated from the seeds, cleaned of foreign material, and pressed into bales of lint and sent to market for trade.
- **Chemical defoliant for mechanical harvesting:** Harvest aid chemicals such as desiccants and defoliant are commonly applied prior to harvest. Desiccants are substances intended to artificially accelerate the drying of plant tissue and are used in regions with short growing seasons. Defoliant are applied in picker operations to remove leaves from the mature plant. Then, harvesting is done by cotton pickers, which removes only the seed cotton (fiber and seeds), which results in less trash and good quality lint.
- **Production status and yield levels:** The United States produces about 3.6 million tons of (20.4 million bales) cotton per year with a productivity of 750 to 900 Kg/ha.
- **Crop rotation with sorghum:** In order to maintain the soil fertility, the cotton crop is rotated with sorghum in every alternative cropping seasons.
- **No-tillage / Conservation farming practices:** Approximately 52 percent of the cotton grown on no-tillage or some form of conservation tillage practices to reduce soil erosion, improve soil health, water conservation and lower production costs.
- **Export oriented production:** USA is the largest exporter of cotton lint in the world accounts for about 36 % of the total cotton lint exports in the world. It is mainly because of export oriented cultivation which ensure highest possible lint quality through appropriate management practices. The USA cotton industry having an annual export volume of 2.4 to 2.5 million tons (13.6 million bales).
- **By-products - Cotton seed oil & cotton seed meal:** After the lint is removed, oil is extracted from the seed, the most valuable by-product. Solvent extraction or presses remove the oil. After further processing, the oil is used in cooking or salad oil, shortening and margarine. Limited quantities also go into soaps, pharmaceuticals, cosmetics, textile finishes and other products. The remaining meat of the kernel is converted into meal, the second most valuable by-product. High in protein, it is used in feed for all classes of livestock and poultry.

The study visit given an overall understanding of cotton cultivation under high density planting system with complete mechanisation from planting to harvesting. The interactions with the experts, farmers, and industrialists during the study visit was an eye opener to note, which would help us in going ahead in promoting high-density cotton and farm mechanisation in the State of Telangana.

In view of the above, the following points are submitted for the immediate actions for the benefit of the farmers.

- **Research & Development of suitable cotton varieties/hybrids:** Promotion of cotton varietal research and development suitable for high-density planting systems including earliness, dwarf compact, synchronized maturity, and rainfed adoptable varieties/hybrids, and amenable for mechanization. In addition, breeding programmes need to be focused on enhancing cotton yields and doubling the income of the farmers.
- **Farm mechanisation:** The farm machinery industry needs to be promoted to make machines that suit Indian conditions and small farm holdings. The manufacturers of farm machinery may be encouraged by providing incentives and farmers may be provided subsidies to purchase cotton seed planters, and pickers, and set up modern ginning mills for higher ginning outturn and fiber quality.
 - a) **Pneumatic planters:** Precision planters are important machines in the regime of modern technological agriculture. The use of pneumatic planters for precision seeding of cotton seed will reduce the cost of sowing and labour requirements. The pneumatic planters are easy to use, constantly reliable, and highly accurate. These should be made available in a number of configurations and with different kinds of frames to meet the local requirements of our farmers.
 - b) **Mechanical cotton pickers:** Cotton picker machines helps in timely harvesting of cotton and avoids damage to the cotton by wind or rain. These are essential in HDPS cotton and reduces farmer's cost of cultivation and improve their competitiveness.
 - c) **Support for domestic farm machinery manufacturers:** The manufacturing companies need to be encouraged to design and fabricate simple pneumatic planters and mechanical cotton pickers that are suitable for local requirements and amenable for small farm holdings.
- **Cotton as a 2nd crop / Summer season:** Cotton is also being grown as summer crop in the USA, as per the discussion with the US crop scientists, it can be grown as a second crop in summer season in Telangana due to the prevalence of suitable agro-climatic conditions coupled with availability of assured irrigation. Hence, need to take trails on cotton cultivation as a second crop /summer crop.
- **Cotton pre cleaners at farm level:** Cotton stripper (Single pick harvesters) Stripper harvesting causes a lot of trash in the cotton and requires a long chain of cleaning processes in the gin. Cotton quality is affected by all these processes. The field cleaner turned out to be a valuable cleaning step for spinning performance and yarn.
- **Modern ginning technology:** Cotton ginning plays very important role in separation of fibres from cotton seed and converts field crop into a saleable commodity i.e. lint. Ginning acts as a bridge between cotton farmer and textile industry. Indian cotton ginning technology needs to be improved significantly with the establishment of new ginners which are suitable for efficient ginning to obtain the optimum ginning outturn and to make more profit with the best fiber parameters after ginning and making lint the most important industrial raw material for example, the bunch of fiber on seed (ginning out turn) is more than 44% in few countries.
- **Modernisation of textile mills:** Modernisation of cotton textile mills needs to be promoted like, encouraging the adoption of modern equipment in the spinning mills to remove trash and improve the cleanliness of cotton to ensure Indian cotton fetches better prices in international markets. The textile industry must be involved in making the necessary changes to the machines in ginning mills and spinning mills to improve cotton textile quality.

- **Large scale demonstrations:** The demonstration is a unique approach to provide a direct interface between technologies and farmers and get direct feedback from the farmers' field about the high-density planting systems. Field demonstration / mini kits should be increased in all the cotton growing districts so as to sensitise the farmers about the high-density planting system and modern technologies including mechanisation.
- **Intensive capacity building programs for farmers:** A massive and intensive capacity-building programmes by involving farmers needs to be organized on cotton production aspects like crop management, pest/weed control, irrigation/ nutrient management, farm mechanisation, quality lint production, pre-cleaning at farm level etc. so to as to ensure production of good quantity and quality lint and higher ginning out turn.
- **Improvement in agronomic practices:** Agronomic-management systems for exploiting more productivity per unit area and robust management procedures to ward off pests, diseases and other nutritional disorders should be standardised by the State Agriculture University as per the local conditions.
- **Promotion of micro irrigation in cotton:** In order to save water, electricity and labour requirement, the micro irrigation methods like drip / sprinkler irrigation in cotton should be encouraged. This will lead to improvement in cotton yield and fiber quality simultaneously reducing the cost of cultivation.
- **Effective Defoliant to aid mechanised cotton harvesting:** In the context of mechanised cotton harvesting, defoliant play a critical role. Which reduces the cost of labour used for picking cotton and maximum cotton can be picked in a single pick. It also results in higher net returns and benefit -cost ratio without compromising the lint quality. Therefore, need to focus our research studies on defoliation in cotton using different chemicals and different defoliation methods that suit local conditions and small farm holdings.
- **Focus on export opportunities:** There is a lot of export opportunities in South-East Asian countries like Vietnam, Thailand, Bangladesh etc, who are importing cotton lint from US to feed their cotton textiles industries. Having scope for increasing area under cotton and with quality consciousness, Telangana can be a potential cotton lint supplier to these countries.
- **Research Collaborations:** Need to have research collaborations with US cotton research institutes on high density cotton research activities and farm mechanisation wherever it is required.
- **Long term strategies:** There is a need for a holistic and a long-term strategic approach. Multiple links in the value chain have to be optimised and technologically upgraded, starting from cotton seed, crop protection, crop nutrition, irrigation, mechanisation, markets, ginners and the end user and need to adopt breakthrough technologies and implement new production system like HDPS.
- **Next generation technology deployment:** Need to expedite the approval of the new generation cotton biotech traits like BG-III for effective insect and weed management in cotton to ensure the production of contamination free good quality and quantity of lint to ensure good prices for the farmers. Otherwise, it would be a major challenge in implementation of new technologies for ensuring sustainability of cotton production in future.

In order to address the above points, it is proposed to have a Stakeholders Brainstorming meeting by involving all the stakeholders to discuss and take further actions.

Glimpses of Study Visit



Interaction with Cotton farmer at Memphis, Tennessee State



Cotton fields at Memphis, Tennessee State



Bayer Crop Science, St. Louis, Missouri State



Cotton planters at Memphis, Tennessee State



BASF facilities at Memphis, Tennessee State



Interaction with scientists at Bayer Crop Science, St. Louis, Missouri State



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