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Cotton Exchange Building, 2nd Floor, Cotton Green, Mumbai - 400 033
Phone: 3006 3400 Fax: 2370 0337 Email: cai@caionline.in
www.caionline.in

The Future of Cotton

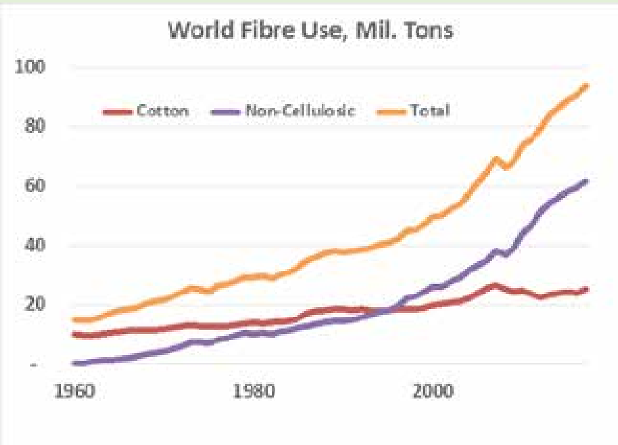
EXPERT's Column

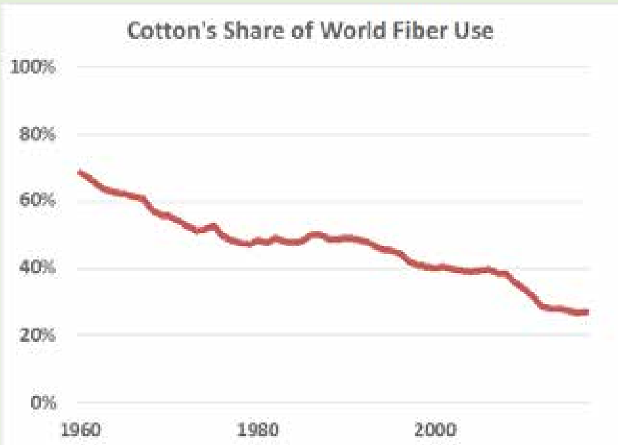
Dr. Terry Townsend

With a Ph.D. in Agricultural and Resource Economics from Oregon State University in the USA, Dr. Terry Townsend is a consultant on commodity issues. He is currently working with the African Cotton and Textile Industries Federation (ACTIF). He served as executive director of the International Cotton Advisory Committee (ICAC) and has also worked at the United States Department of Agriculture for five years, analyzing the U.S. cotton industry and editing a magazine devoted to a cross-section of agricultural issues.

Since the 1960s when world fibre use was approximately one-eighth of the current level, almost all the growth in consumption has occurred with polyester and cotton, especially polyester. While there have been year-to-year fluctuations in demand for all fibres, consumption of wool, other natural fibres such as silk and flax, and non-cellulosic fibres such as nylon have either been relatively flat or declining.

Prior to the 1900s, all fibres were natural, and in the 1960s, natural fibres still represented 70% of world fibre use. By the 1980s, the natural fibre share had fallen to about half, and while the downward trend abated during the 1980s, the downward slide in market share continued in the 1990s and 2000s.





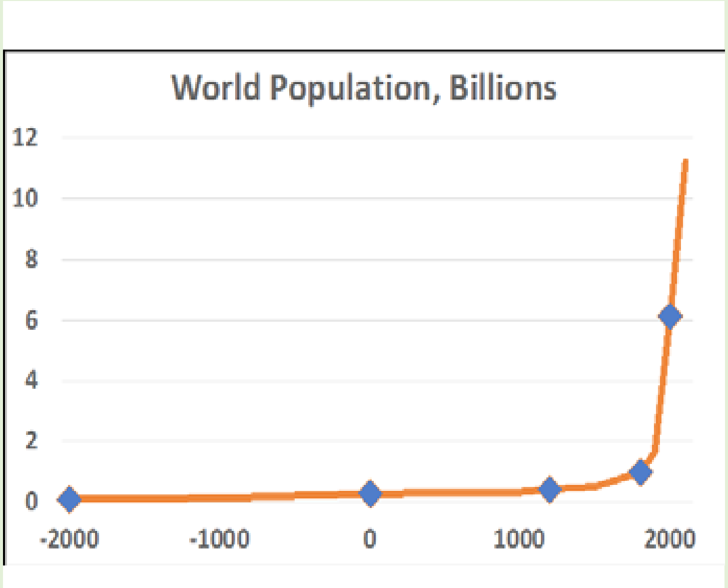
Keeping Cotton Competitive

Consumers, not producers, determine which products are competitive, and cotton must meet consumer demands for products with desired fibre performance properties at competitive prices. Cotton production must also return an income to growers that justifies investments in land, labor and capital.

In order to achieve higher yields and increased production while reducing resource consumption, world agriculture, including the cotton industry, needs to be able to utilise new developments in agricultural sciences. Accordingly, consumer rejection of the products of biotechnology (GMOs) poses a major threat to the future of cotton production.

Agricultural Technology in Perspective

To put the importance of technology in perspective, it is helpful to look at the history of mankind and world population growth. According to United Nations population estimates, the world population in 2000 BC was approximately 70 million. 2,000 years later, the world population had grown by just 230 million to 300 million. Incredibly, because of disease and warfare, the world population was still 300 million by 1000 AD, but it had grown to 500 million by 1500 AD. With the start of the European Renaissance, world population growth started to accelerate and reached nearly 1 billion by 1800. Population grew to 1.7 billion by 1900, and then exploded to 6.2 billion in 2000. As of today, the world population is estimated at 7.5 billion, climbing to a forecast 11.2 billion by 2100.

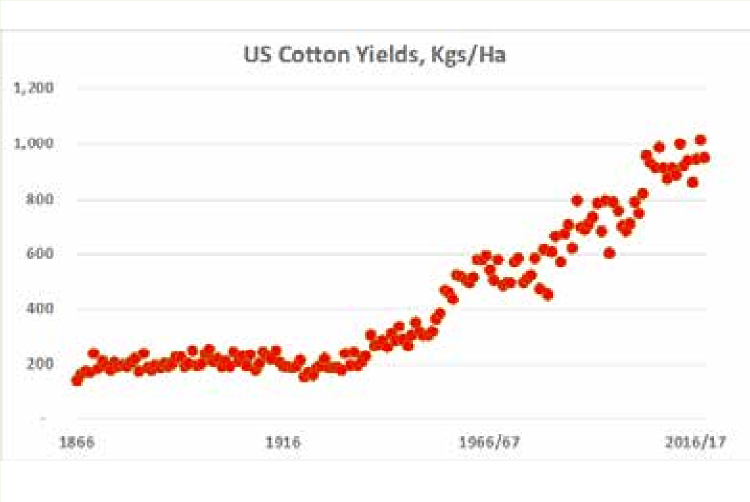


Prior to the last century, starvation was a routine part of human existence for thousands of years. Medicine and sanitation have saved the lives of billions, and a host of other technologies ranging from air-conditioning to elevators, have made life more comfortable. However, these developments would be of little value if people still routinely starved to death and starve people did. Prior to the most recent century, famine caused by crop failure occurred in every region so commonly it was not always even noted. A Wikipedia list of famines is 24 pages, and this list is hardly exhaustive but includes only those famines large enough in history to have attracted notice. (https://en.wikipedia.org/wiki/List_of_famines)

Hunger, and even famine, still occur in the 21st century. However, want today is a product of uneven distribution, war or dysfunctional governments, not crop failure per se. The ability to defeat famine is one of the greatest achievements in the history of mankind.

Technology Drives Yield Growth

The role of agricultural science in improvements in productivity is apparent in data on cotton yields from the United States.



From the 1860s to the 1920s, when all agriculture was entirely organic, there were no gains in U.S. cotton yields, which averaged 200 kilograms per hectare. Small year-to-year variances occurred with weather and pest pressure, but there were no significant structural changes in productivity.

However, since the 1920s, the yield in the United States has risen five-fold to one ton per hectare, mirroring changes in agricultural productivity in all crops. The major technologies that have driven these achievements include directed breeding, mechanisation, synthetic fertilizers, plant protection chemicals, and most recently the tools of genetic engineering.

Gregor Mendel experimented with pea plants in a garden between 1856 and 1863 and established many of the rules of heredity that underlie the modern science of genetics. His work was not understood for many decades, but after World War I, scientists began applying the principles he developed in commercial breeding programs, and agricultural yields began to rise in the 1930s.

Mechanisation of agriculture began with rudimentary animal-powered machines in the 1800s, but the development of modern machinery during World War II led to widespread adoption of tractors and associated implements. Mechanisation not only reduces labour, but it also enhances yields by allowing for uniform plant spacing in even rows to ensure proper nutrient management. By the 1950s, the yield in the United States had doubled to 400 kilograms per hectare.

In the 1960s and 1970s, scientists and engineers developed synthetic nitrogen for fertilizer and plant protection chemicals to control weeds, disease and insects, and by the 1980s, the United States yield rose to between 600 and 800 kilograms per hectare.

Biotechnology: The Newest Driver of Change

And in the 1990s, world agriculture was transformed with the commercial release of varieties containing herbicide tolerant (HT) and insect resistant (IR) traits. Insect-resistant GM cotton is commonly referred to as Bt, short for Bacillus thuringiensis, a common soil bacterium. One or more genes from Bt are inserted into the cotton genome, producing increasing levels of one or more proteins that cannot by digested by a category of insects called bollworms, what most people would call caterpillars. The expression of the protein increases as the plant matures and becomes increasingly toxic to the bollworm. Bt cotton serves as a substitute for insecticides in controlling chewing pests.

Weeding is an extremely labour-intensive process, requiring 30 to 40 man-days per hectare per season if done manually. HT cotton is seen as an essential component of mechanised cotton farming systems in countries where labour is expensive. HT cotton contains genes that protect the crop from the toxic effects of specific broad-spectrum herbicides. When HT cotton is planted, herbicides can be sprayed in the field, resulting in weed control without harming the crop. In addition to weed control, the HT technology is also used to kill cover crops in conservation tillage systems.

Future Technology Developments

Developments in agricultural sciences have not stopped, and cotton production might be dramatically changed in the next few decades. Already, scientists in Uzbekistan have announced the discovery of genes in cotton's DNA that regulate root length. By using a tool of biotechnology known as CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats), scientists have been able to delete specific genes in cotton varieties resulting in longer root growth. The objective of the research was to enhance drought and salt tolerance, major problems in cotton production in Central Asia, but the discovery has inadvertently also led to varieties with longer fibre lengths. The varieties are currently in field trials in Uzbekistan. (I.Y. Abdurakhmonov, "High quality RNAi-cotton cultivars with superior fibre quality and improved agronomic traits," ICAC Plenary Meeting, Abidjan, Cote d'Ivoire, 2018).

The use of cotton seed meal and oil in food for human consumption is limited by the presence of gossypol, a naturally occurring toxin produced by cotton as a self-defense mechanism. Dr. Keerti Rathore of Texas A&M University, United States, reports that cotton varieties expressing normal levels of gossypol in the green portions of the cotton plant, but ultra-low levels of gossypol in the cotton seed, have been developed and approved for commercial release by the United States Department of Agriculture. (Cotton Statistics and News, Issue No. 39, 25 December 2018). This development could dramatically increase the value of cotton seed outside of Africa and Asia, thus enhancing the total value of seed cotton produced by farmers.

Dr. David Stelly, Professor, Department of Soil Sciences, Texas A&M University, United States, says that progress has been made in seed genotyping. He contends that germplasm resources and wild species of cotton contain useful traits that can be utilised to enhance diversity to develop new germplasm and cultivars that will be able to combat climate change and biotic stress factors. Tools and strategies that will enable the realisation of these objectives include endophytes, RNAi, protein-guided and RNA-guided gene editing, CRISPR /Cas9; transcriptional enhancers or repressors to experimentally modify expression and histone methylase/demethylase to target changes of histone methylation. Echoing a theme of the importance of consumer and regulatory acceptance of such technologies, Dr. Stelly has noted that, "Genetic engineering is going to be big, unless we stop it from being big." (ICAC Plenary Meeting, Tashkent, Uzbekistan, 2017.)

As another example, the US research firm Cotton Incorporated, has developed a new 100% cotton fabric that is being marketed under the Natural StretchTM brand. The fabric offers the same elasticity and comfort currently provided only by fabrics containing elastane, often known as spandex or lycra.

These and similar examples of breakthrough developments in cotton technology via the use of the burgeoning field of life sciences show what can be done to transform cotton in the coming decades. But these breakthrough developments will only be possible if they are permitted and accepted.

Like its sister natural fibres, cotton will eventually be supplanted by polyester if it cannot improve production practices through the application of developments in the agricultural sciences. Thus, the gravest threat to the long run sustainability of the world cotton industry, and the livelihoods of millions of producers, is not polyester fibre itself, but potential consumer and regulatory rejection of the applications of agricultural sciences.

Imagine the Future

Imagine a person standing on the deck of a sailing ship in the 1850s. Would it have been even remotely possible for that person to predict the development of a modern passenger cruise ship or cargo carrier? Likewise, as we look at the world cotton market today, is it even possible to imagine how this industry will look in 50 or 100 years?

Cotton is one of the world's greatest industries, touching almost every person every day, providing incomes to tens of millions, connecting producers in far-flung zones to world markets, and enhancing food security. But the industry must change or it will shrink. Just as sailing ships have given way to modern ships, enabling the ocean passenger and freight industries to compete with planes, trains and automobiles, so must cotton change to compete with polyester.

Only science can enable cotton to survive in a competitive environment in which consumers determine outcomes. Go back to the sailing ship in the 1850s. Imagine that consumers and governments, afraid of pollution, worried about operator safety, concerned about design flaws in early models, fearful of onboard fires, banned the use of coal or oil fired engines in ships and instead promoted "wind power" as safe and sustainable, even as they allowed the development of airplanes, railroads and automobiles. Obviously, our world today would be entirely different.

Today's urbanised consumers and government officials, far removed from the realities of agriculture, secure in a world of abundance they take for granted, could do to cotton, and to agriculture generally, what a ban on the use of engines would have done to the shipping industry in the age of sail.

If there is a lesson in the long sweep of human history and population growth, it is that science helps. Of course, there are missteps (DDT) and dead ends (fluorocarbons), but the process of science and the tools developed from that process are the keys to human betterment. Without them, cotton cannot compete for long against an industrial alternative. With the use of the tools of science, cotton may be as ubiquitous in the next century as it is now.

(The article was adapted from a presentation made before the International Textile Manufacturer's Federation Annual Conference, September 2018, Nairobi, Kenya)

(The views expressed in this column are of the author and not that of Cotton Association of India)

Role of Disruptive Innovations in Transformation of World Agriculture and Cotton Scenario: - Digital Technologies (Part 1)

Continued from Issue No. 17 dated 23rd July 2019

GUEST COLUMN

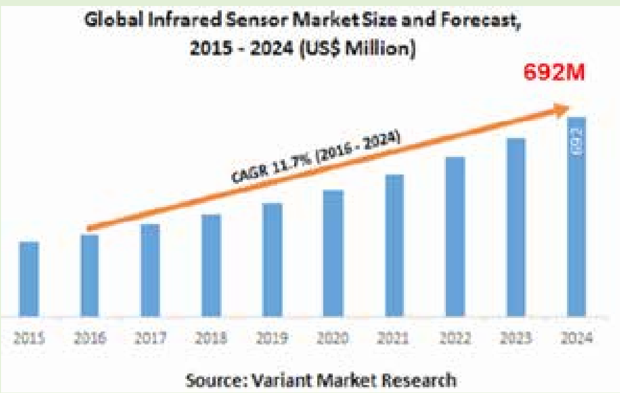
Dr. Brijender Mohan Vithal
Cotton Expert

Dr. Brijender Mohan Vithal has a Ph.D. Agric (Plant Breeding-Cotton) from Punjab Agriculture University (PAU) Ludhiana. He has been associated with cotton R&D activities for more than three decades. He has worked as a Senior Cotton Breeder with PAU, GM Production / Executive Director with National Seeds Corporation and Director, DOCD, Ministry of Agriculture (MOA). He was Officer on Special Duties (OSD) to look after activities related with Tech Mission on Cotton (TMC) in CCI Ltd during its pre-launch period. He joined CCI Ltd - TMC Cell (MMIII & IV) during 1999 and continued working there till the end of the TMC Project in December 2010. He is still associated with cotton through agencies like ISCI.

3. Sensors:

Sensors may soon be the most ubiquitous digital technology in agriculture, as they deliver a tremendous array of functions (covering a wide range of agriculture arenas, from crops to livestock) and are very affordable. They can be used to analyze the air, water or soil of a field or a greenhouse. For example, use of infrared spectrum that is otherwise invisible to the human eye. The resulting information can be analyzed and displayed graphically on a computer, thus allowing detailed analysis and providing forecasts and remedies for problems such as drought or disease. They can even be used to warn away predators by sensing the animal's behavior through its movement and signaling flashing lights.

In Japan, Tokihiro Fukatsu was a pioneer in the wearable technology industry and many others have followed his research closely to establish their own companies. The market for agricultural sensors expected to reach by 2024 has been presented (below) in a graphic form.



4. Artificial Intelligence (AI):

Artificial Intelligence (AI) takes the data gained from sensors and converts it to useful information. AI refers to machines that can mimic "cognitive" functions such as "learning" and "problem solving". An exciting example in agriculture is machine vision, where computers process visual data collected via UAV, satellite or even smart phones and provide the farmer with useful information. For example:-

- The Fermentrics Company is using AI to reduce inefficiencies in food production. Using machine vision (image-based automatic inspection) allows for constant monitoring of fields. This information can then be used to reduce irregularities in growth or production and to be identified before they become problems.

- Most importantly companies like Cainthus are developing algorithms to identify animal behavior and productivity on an individual basis.

AI is particularly important because it can interpret information far better than humans and can be used to filter data and allow humans to only become involved when it is absolutely necessary.

5. 3D Printing:

3D printers are becoming familiar, but their potential is still massively untapped. This is particularly true in the agribusiness arena. There are obvious, easy applications on farm, as in using a 3D printer to create a needed part for a repair, thereby increasing self-sufficiency and avoiding potential losses in production. More ambitiously, it could allow farmers to develop alternative parts to suit their particular requirements.

6. Augmented Reality (AR):

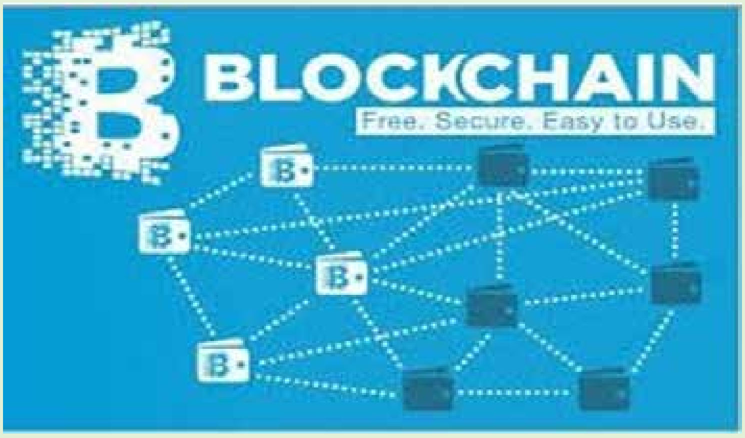
Augmented Reality (AR) sometimes called 'mixed reality' is the addition of information, typically by computers or sensors, to that of the real world. It is the middle ground between reality and virtual reality. An example is the ability of computers to see spectrums of light that the human eye cannot pick up, but which might contain useful information for decision making. Farmer can use AR to layout the planting options in a field or by a fertilizer salesman to demonstrate the impact his product could have on his customer's field. The argument with AR is that it is more than images superimposed on a computer screen, the user needs to actually see the virtual images as part of the real image before him (such as with Google's Glass). The technology is still very expensive, but high-value uses such as identifying pathogenic bacteria in the food chain are likely to be among the early applications.

7. Virtual Reality (VR):

Adoption of Virtual Reality (VR) technology has also slowed down by high implementation costs, but as with the other technologies here, the prices are coming down very quickly. A likely early use of VR in cotton field video is the monitoring systems that send data back to a computer program, which in turn constructs a visual representation of the crop allowing the farmer to check in for further treatment against pests and diseases. A natural extension would be training employees and workers for on-farm work. Despite the many possible applications and uses, this is one technology that may still be way off from fully integrating itself into the agriculture industry.

8. Block Chain:

As with the other technologies listed, a block chain is a way of using technology to gather, interpret and share information. In this case, it is the information that goes along the food chain. Having a solid source of reliable information about food, including where it was grown; how it was processed, stored and transported; who was in control at each stage of the journey (it is like the 'Information Tag' put on each cotton bale) has been a challenge ever since people started trading for food. These days, with an increasingly global food chain, and ever more complicated compliance requirements the information chain is more important than ever. Block chain is essentially an incorruptible electronic ledger that can track each transaction of a food item's journey through the food chain. From a legal standpoint, the encryption allows for safekeeping of information, reducing the need for lawyers or legal action. Given below is the diagrammatic view of a block chain system.

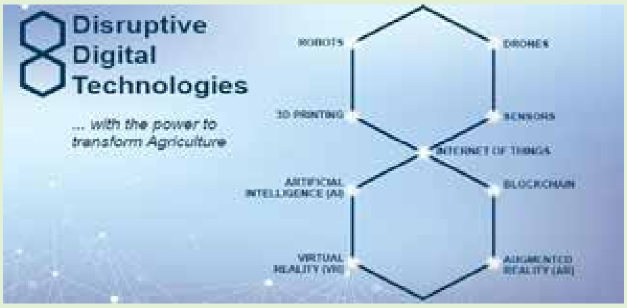


Essentially, every entity that handles the item submits the relevant data, which is recorded and accessible to anyone else in the chain. In return, they also have access to everyone else's data and records, so there is full transparency. It is done through a chain of third party providers, and no one entity has the ability to manipulate the data, so it is secure. Farmers and producers can connect to and access the block chain to make information more available. As the agriculture sector has one of the biggest disconnects between suppliers and retailers, block chain has the ability to create direct links among participants of the supply chain thereby ensuring farmers are paid fairly and retailers receive the right products. Wal-Mart recently began testing a food chain.

Block chain monitors its food procurement and sales, both in the US and China. If problems arise, Wal-Mart can immediately trace the food and identify which other stores have the same item, allowing it to immediately remove it from its shelves, and there is a clear chain that will help quickly identify the source of the problem. Given that each year almost 10 percent of consumers suffer from consuming contaminated food; this technology has the potential to directly affect the consumer in a monumental way.

The Eight Disruptive Technologies At A Glance

To better understand all the eight disruptive technologies at a glance, their diagrammatic representation is given below:-



The eight technologies discussed in this article are already in play, representing tremendous opportunities for those who recognise their implications. Not just obviously, agribusiness participants - the farmers - who recognise that they must be not just farmers of crops but are also farmers of food marketers. They haven't realised so for that they are connected with the larger agribusiness community.

Right now, a cross-section of technologies and disciplines – from sensors, artificial intelligence and big data to biotech and robotics – are being used by progressive startups to boost global food and fibre supplies. For example, Automated Disease Detection Technology, Smart phones, Precision Farming Technology, Self-Driving Tractors, Fin Tech startups, Use of biotechnology and many more. More details of adoption of such high technologies to boost cotton cultivation will be discussed separately.

(The views expressed in this column are of the author and not that of Cotton Association of India)

Update on Cotton Acreage (As on 25.07.2019)

(Area in Lakh Ha)

Sr. No.	State	Normal Area (DES)*	Normal Area as on Date (2014-2018)	Area Covered (SDA)					
				2019-20	2018-19	2017-18	2016-17	2015-16	2014-15
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	Andhra Pradesh	6.56	3.669	2.300	3.230	3.506	2.850	2.780	5.980
2	Telangana	17.00	14.560	15.876	16.390	16.800	11.220	15.210	13.180
3	Gujarat	26.04	23.478	22.505	21.843	25.846	20.380	23.480	25.840
4	Haryana	6.06	6.078	6.760	6.650	6.560	4.980	5.810	6.390
5	Karnataka	6.47	3.974	2.673	3.060	3.850	3.600	3.690	5.670
6	Madhya Pradesh	5.65	5.592	6.000	5.240	5.730	5.270	5.420	6.300
7	Maharashtra	41.48	35.787	40.631	36.783	38.470	36.270	36.100	31.310
8	Odisha	1.31	1.270	1.520	1.310	1.431	1.260	1.190	1.160
9	Punjab	3.56	3.650	4.020	2.840	3.850	2.560	4.500	4.500
10	Rajasthan	4.76	4.272	6.360	4.961	5.017	3.740	3.490	4.150
11	Tamil Nadu	1.61	0.036	0.035	0.037	0.034	0.033	0.030	0.046
12	Others	0.43	0.230	0.271	0.172	0.286	0.170	0.210	0.310
All India		**120.930**	**102.595**	**108.951**	**102.515**	**111.380**	**92.333**	**101.910**	**104.836**

** Directorate of Economics & Statistics, Ministry of Agriculture and Farmers Welfare, Krishi Bhavan, New Delhi*
Source : Directorate of Cotton Development, Nagpur

UPCOUNTRY SPOT RATES

(Rs./Qtl)

Standard Descriptions with Basic Grade & Staple in Millimetres based on Upper Half Mean Length [By law 66 (A) (a) (4)]							Spot Rate (Upcountry) 2018-19 Crop July 2019					
Sr. No.	Growth	Grade Standard	Grade	Staple	Micronaire	Strength /GPT	22nd	23rd	24th	25th	26th	27th
1	P/H/R	ICS-101	Fine	Below 22mm	5.0-7.0	15	11501 (40900)	11501 (40900)	11501 (40900)	11501 (40900)	11501 (40900)	11501 (40900)
2	P/H/R	ICS-201	Fine	Below 22mm	5.0-7.0	15	11642 (41400)	11642 (41400)	11642 (41400)	11642 (41400)	11642 (41400)	11642 (41400)
3	GUJ	ICS-102	Fine	22mm	4.0-6.0	20	9561 (34000)	9561 (34000)	9617 (34200)	9561 (34000)	9561 (34000)	9420 (33500)
4	KAR	ICS-103	Fine	23mm	4.0-5.5	21	10854 (38600)	10854 (38600)	10854 (38600)	10854 (38600)	10854 (38600)	10798 (38400)
5	M/M	ICS-104	Fine	24mm	4.0-5.0	23	11417 (40600)	11417 (40600)	11417 (40600)	11417 (40600)	11417 (40600)	11360 (40400)
6	P/H/R	ICS-202	Fine	26mm	3.5-4.9	26	12570 (44700)	12541 (44600)	12541 (44600)	12513 (44500)	12513 (44500)	12457 (44300)
7	M/M/A	ICS-105	Fine	26mm	3.0-3.4	25	11445 (40700)	11445 (40700)	11445 (40700)	11445 (40700)	11445 (40700)	11389 (40500)
8	M/M/A	ICS-105	Fine	26mm	3.5-4.9	25	11782 (41900)	11782 (41900)	11782 (41900)	11782 (41900)	11782 (41900)	11698 (41600)
9	P/H/R	ICS-105	Fine	27mm	3.5.4.9	26	12626 (44900)	12626 (44900)	12626 (44900)	12541 (44600)	12541 (44600)	12541 (44600)
10	M/M/A	ICS-105	Fine	27mm	3.0-3.4	26	11698 (41600)	11698 (41600)	11698 (41600)	11698 (41600)	11698 (41600)	11670 (41500)
11	M/M/A	ICS-105	Fine	27mm	3.5-4.9	26	11951 (42500)	11951 (42500)	11951 (42500)	11951 (42500)	11951 (42500)	11951 (42500)
12	P/H/R	ICS-105	Fine	28mm	3.5-4.9	27	12682 (45100)	12682 (45100)	12682 (45100)	12598 (44800)	12598 (44800)	12626 (44900)
13	M/M/A	ICS-105	Fine	28mm	3.5-4.9	27	12204 (43400)	12232 (43500)	12232 (43500)	12204 (43400)	12204 (43400)	12204 (43400)
14	GUJ	ICS-105	Fine	28mm	3.5-4.9	27	12288 (43700)	12317 (43800)	12288 (43700)	12232 (43500)	12232 (43500)	12176 (43300)
15	M/M/A/K	ICS-105	Fine	29mm	3.5-4.9	28	12485 (44400)	12485 (44400)	12457 (44300)	12373 (44000)	12373 (44000)	12373 (44000)
16	GUJ	ICS-105	Fine	29mm	3.5-4.9	28	12485 (44400)	12485 (44400)	12485 (44400)	12401 (44100)	12401 (44100)	12345 (43900)
17	M/M/A/K	ICS-105	Fine	30mm	3.5-4.9	29	12823 (45600)	12795 (45500)	12738 (45300)	12598 (44800)	12598 (44800)	12598 (44800)
18	M/M/A/K/T/O	ICS-105	Fine	31mm	3.5-4.9	30	13132 (46700)	13076 (46500)	13020 (46300)	12879 (45800)	12879 (45800)	12879 (45800)
19	A/K/T/O	ICS-106	Fine	32mm	3.5-4.9	31	13441 (47800)	13441 (47800)	13385 (47600)	13301 (47300)	13301 (47300)	13301 (47300)
20	M(P)/K/T	ICS-107	Fine	34mm	3.0-3.8	33	15466 (55000)	15325 (54500)	15325 (54500)	15185 (54000)	15185 (54000)	15185 (54000)

(Note: Figures in bracket indicate prices in Rs./Candy)