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High Density Planting System in Cotton - An Agro-Technique to Reverse Yield Plateau

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GUEST COLUMN

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In the last decade, yield of cotton has stagnated in the country and it is feared that the productivity during 2018-19 would be the lowest. This is despite the fact that almost 90% of the farmers have adopted the state of art BG II hybrids. The cost of cotton cultivation has increased from Rs. 2233/q of seed cotton in 2002-03 to Rs.4803/q in 2015-16, mainly due to increase in labour wages and increased use of inputs fertilizers and pesticides. Climate change/variability induced aberrations in rainfall distribution, increasing frequency of extreme events like drought and uncertain prices have further increased the risk of rainfed cotton production. The overall effect has been a decline in profit of the farmer from cotton cultivation.

About 60% of the cotton in India is cultivated under rainfed conditions where even life saving, supplementary irrigation is rarely available. The monsoon sets in by mid-June and recedes by mid-September. Cotton crop requires very high amount of water during the peak boll formation phase, which in the present day hybrids occurs from mid-October to mid-November in Central India. On shallow and medium deep soils, the soil moisture retained is insufficient to meet the high water requirement of the crop during this period resulting in poor boll formation / retention and low yields under rainfed conditions. It is understood that low plant density and a gross mismatch between the growth and fruiting pattern of the present day hybrids and the rainfall pattern and soil

moisture supply are the main reasons for low yields.

Under these conditions, High Density Planting System (HDPS) of early maturing, semi- compact genotypes, an initiative of ICAR-Central Institute for Cotton Research, Nagpur offers a viable alternative for higher yields with low production costs under rainfed condition. The technology is also suitable for irrigated cotton with suitable modifications. During the last few years, HDPS is being projected by scientists, policy makers, NGOs and farmers as the next game changer in cotton production in India. This article intends to provide an understanding into the basic tenets of HDPS and highlights the research and promotional efforts made in India to promote HDPS.

What is HDPS

Over the last few decades, many cotton growing countries like China, USA, Australia, Brazil, Uzbekistan and Greece were able to enhance cotton yields by increasing the planting density. The planting geometry adopted is 8-10 cm distance between plants in a row at row spacings ranging from 18 to 106 cm. The planting systems are referred as narrow row (NR) if the row-to-row spacing is less than 75 cm and ultra-narrow-row (UNR) if the spacing is less than 45 cm.

Currently in India, depending on the local conditions, hybrid cotton is planted at row spacing ranging from 90-120 cm and plant spacing ranging from 30-90 cm resulting in 15000 to 25000 plants/ha. In HDPS, short duration, semi–compact cotton varieties are planted at populations ranging from 1.1 lakh to 2.45 lakh plants /ha by planting at a distance of 45-90 cm between rows depending upon the soil type and growing conditions and 10 cm between plants in a row. It aims to establish around 7-8 plants/m row length. The objective is to limit the boll number to 6-8 bolls/plant, maximise the number of bolls/unit area and realise high yield in the shortest possible time. If the number of bolls/plant is few, the fruiting window (or flowering period) is short (4-5 weeks) and the plant matures early, producing fibres with good quality.

Why HDPS Was Not Attempted Earlier in India

1. Cotton breeders consciously bred bushy, monopodial varieties resembling hybrids with the aim of maximising the number of bolls/plant. Breeding for early maturing, dwarf, compact varieties with fruiting bodies close to the main stem that would suit HDPS, was not a priority.

2. Mechanical picking warranted short, compact (short sympodes) and determinate plants. To retain their architecture and maximise productivity from these plant types, close planting was a necessity. Since mechanisation of picking was not a priority in India, attempts in this direction were few.

3. Cotton agronomists concentrated on optimising geometry/plant density for the varieties developed by breeders. They also manipulated inter-row and inter-plant spacing to fit in suitable intercrops, permit inter-culture or facilitate soil moisture conservation. Maximising boll number per unit area at high populations, key for high productivity under HDPS, was not attempted.

4. It was believed that altered microclimate with high plant density would increase weeds and also aggravate insect pests and diseases. Even with the availability of both pre and post emergence herbicides and new generation potent insecticides, HDPS was not promoted.

5. Plant monitoring and regulation of excess vegetative growth using growth regulators was not standardised. These would have altered the morpho-frame of cotton varieties to fit into HDPS.

Research on HDPS in India

Research on HDPS on cotton gained momentum under the leadership of ICAR – Central Institutes for Cotton Research, Nagpur in 2010. Shortly thereafter, in 2012, the All India Coordinated Cotton Improvement Project (AICCIP, now AICRP on Cotton) started a separate trial on the evaluation of compact genotypes for HDPS under rainfed and irrigated situation, to facilitate release of compact genotypes suitable for HDPS. Variety CSH 3075 was the first cotton variety released for HDPS in India. The salient research findings are summarised below.

- Semi-compact genotypes like PKV 081, Suraj, NH 615, NH 630, ADB 39, LRK 516, F2383, CSH 3075, ADB 39, NDLH 1938 and KC 3

in G. hirsutum and Phule Dhanwantary and AKA 7 in G. arboreum, have morphological traits to fit into HDPS at appropriate row spacing. In these genotypes the average yield improvement under HDPS was around 30% over the recommended spacing (60x30 cm) and the earliness was around 10 days.

- A geometry to accommodate 1.5-2.0 lakh plants/ha is ideal with current semi-compact genotypes and 45x10 or 60x10 cm was found suitable for rainfed conditions under shallow to medium deep soils. Soil types x genotype x row spacing interaction was found to be significant. For deep soils under supplemental irrigation the variety Suraj could be planted at 75x10 and 90x10 cm where as 60x10 cm was optimum on shallow–medium soils under rainfed conditions.

- Cotton planted under HDPS need 25% additional fertilizers over the recommendation for varieties. The nutrient uptake efficiency improved under HDPS.

- Currently available bullock or tractor drawn seed drills/planters can be used for HDPS but there was scope for evaluation of new planting equipments to facilitate precision planting. Subsequent studies at Coimbatore indicated that tractor drawn inclined plate planter was most suitable.

- Application of a growth regulator-mepiquat chloride @ 50 g ai/ha in 2 or 3 splits decreased plant height but yield increase was not consistent under rainfed conditions. Yield increase was observed for tall varieties, on deep soils and under irrigated conditions.

- The intensity of pests and diseases did not increase under HDPS. However, being non Bt varieties, a separate window based IRM strategy was standardised for HDPS.

Production technology for HDPS:

Based on the research results and findings from other contemporary studies, a package of practices was formulated for demonstration of the technology in farmers' fields. Key elements of the HDPS technology are enlisted below.

- Timely sowing in the 3rd week of June or with the onset of monsoon in Central India with bullock/tractor seed drill/planter at 45 × 10 cm (90,000 plants/acre) or 60x10 on medium soils (67000 plants/acre) or 75x 10 cm on deep soils.

- Weed management using Pendimethalin @ 1 liter/acre (Pre-emergence), Pyrthiobac sodium @ 250 ml/acre (post emergence) + 2 intercultures and hand weeding to remove left over weeds

- Need based application of mepiquat chloride @ 20 g ai/acre (2-3 splits from square initiation) can be done but only after systematic plant growth monitoring.

- Sucking pest management with neem oil (1 l/acre) + neem seed kernal powder (1 kg/ acre), management of American bollworm in non-Bt varieties using Coragen @ 60ml/ acre or Flubendamide @ Fame 480 SC 50 ml/ acre (ETL based). For the control of pink boll worms. Fenvalerate –20 EC @ 160 ml/ acre is recommended if the pheromone catch indicates the pest population is above ETL.

- Fertilizer application: 125% recommended NPK + Zinc sulphate @ 5 kg/acre and borax @ 1.0 kg/acre. Foliar spray - potassium nitrate @ 1.5 kg/acre during boll development phase.

Advantages and Limitations of HDPS

- Early crop maturity and higher production on areas with short growing season

- Suitability for rainfed cotton production on shallow and medium deep soils where cotton crop invariably experiences terminal drought.

- Synchronous bursting making plants amenable to mechanical harvesting

- Smaller window for protection against bollworms and hence lower insecticide requirement and reduced production costs

- Absence of leaf reddening and negligible incidence of para-wilt

The system has the following limitations-

- Soils with high fertility may promote

excessive vegetative growth and may need growth regulators to curtail growth

- Initial weed management is critical as cross-wise hoeing is not possible

- Varieties currently recommended are non-Bt, hence scouting for bollworms is essential. With the availability of Bt varieties this would no more be a limitation.

Secrets for High Yield under HDPS:

1. Selection of appropriate genotype and plant geometry according to soil/ rainfall/ irrigation
2. Timely sowing and early crop establishment
3. Maintaining optimum plant population
4. Scouting for pest management and using only recommended pesticides
5. Retaining the first formed bolls to curtail excess plant growth
6. Soil moisture conservation either by BBF or ridges/furrows

Demonstrations of HDPS on Farmers' Fields:

- More than 5000 participatory demonstrations of this technology were undertaken with able support of SAUs, State Governments, NGOs and KVKs during 2012 to 2016 in 30 districts of 12 cotton growing states viz. Punjab, Haryana, Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, Andhra Pradesh, Telangana, Odisha, Karnataka, West Bengal and Tamil Nadu.

- Among 155 trials across Vidarbha during the year 2012-13, the yields averaged at 6 to 7 q/ acre under rainfed condition which is double the average of the region.

- Inspite of drought in 2015-16, trials in 12 cotton growing states (1294 farmers in 190 villages) recorded average yields of 5.91 q/ acre with Cost: Benefit ratio of 1:1.5

Demonstration plot of HDPS in cotton in Wardha district, Maharashtra

Economic Analysis of HDPS

Economic analysis of the systems was done based on the results in the demonstrations.

Parameters (per acre)	HDPS (Non Bt variety)	Bt hybrid
Seed cost (Rs.)	500	1453
Fertilizer & irrigation cost (Rs.)	800	2436
Pesticides (Rs.)	1000	867
Labour cost (Rs.)	2080	6428
Picking cost (Rs.)	3339	3423
Total Cost (Rs.)	7719	14607
Average seed cotton yield (q)	6.40	6.56
Gross income (Rs.)	27084.8	27762
Net income (Rs.)	19365.8	13155

Source: DOCD, Barik (2016)

Efforts to Increase Planting Density in Bt Hybrids

Studies on Bt hybrids at higher planting densities viz., 35879 plants/ha (90 x 30 cm), 23919 plants/ha (90 x 45 cm), 18000 plants/ha (90 x 60 cm) against 12345 plants/ha (90 x 90 cm) were conducted both at the Agricultural Research Stations and in farmers fields with NCS 145 Bt, NCS 207 Bt, NCS 913 Bt and NCS 138 Bt hybrids. The results indicated that at planting at higher density planting gave around 30% additional yields without affecting the boll size and fibre quality. Closer planting utilised the land, sunlight and nutrients more effectively. The increase in yield was more pronounced on poor soils and when sowings were delayed in the semi arid tropics of India.

CITI along with the Rajasthan government and Bayer Crop Science (BCS) undertook trials in Ajmer, Pali, Nagaur and Jodhpur districts to promote high density planting system for Bt hybrid cotton. Mean results with Surpass 7007 hybrid planted at 90x60, 60x45, 80x30 and 80x15 cm indicated that the yield was highest with 80x15 cm followed by 80x30 cm. CITI is also undertaking a similar exercise in Wardha district of Maharashtra.

Future Perspectives

HDPS is a knowledge intensive cotton production system and for successful adoption of this system, farmers participatory demonstrations are essential. The technology of HDPS elicited great interest across the country. Farmers were convinced about the feasibility of the technology especially under rainfed shallow soil situation. Efforts are also underway to breed ideal a short (90-100 cm) compact, zero monopodial plant types with early maturity, having tolerance to sucking pests, with 6-7 bolls/plant under high planting density with big boll size that would ideally fit into the system. Bt genes have been introduced into the semi-compact varieties already identified suitable for HDPS and this would dispense the fear of American bollworm, a reservation expressed by several farmers. Efforts are also underway to develop strippers to harvest the cotton planted under HDPS that would reduce production costs further and make the system more profitable. The technology has immense potential to ensure that India emerges as the global leader in cotton.

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

COTTON EXCHANGE MARCHES AHEAD

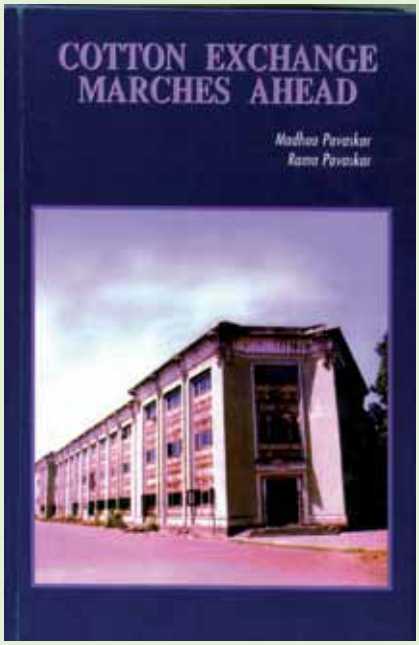
Madhoo Pavaskar, Rama Pavaskar

Chapter 9
In Service of King Cotton

(Contd. from Issue No. 1 dated 2nd April 2019)

Research and Publications

One of the most creditable and laudable services, which the Cotton Exchange has been performing uninterruptedly in both good and bad times for the past over 80 years, is the collection and dissemination of unbiased market intelligence. It is the only organization in the country which collects regularly and most exhaustively all the available statistics on area, production, yields, arrivals, pressings, consumption, imports, exports, stocks and prices of cotton. It also gathers voluminous data on the Indian cotton textile industry, as also the world cotton statistics. What is even more remarkable is that all these data and information are released timely through its weekly publication "Cotton Statistics and News", and later recorded systematically for reference in the yearly comprehensive "Indian Cotton Annual" as well as the more concise "Statistical Abstract – Cotton and Textiles".



The Indian Cotton Annual is an invaluable mine of information on cotton. This unique compendium is of interest to not only the members of the Cotton Exchange, but also the entire cotton community in the country and all the government departments concerned with cotton and its products. It is the one document that nobody in the cotton trade and industry can afford to miss. It has also served the needs of research in Indian Cotton to the scholars and academicians in India and abroad. Since the East India Cotton Association has been publishing the Indian Cotton Annual every year from its inception in 1921, it has become a veritable chronicle of all the ups and downs, the gains and losses and the growths and upheavals faced by King Cotton through the twentieth century.

The East India Cotton Association has also sponsored and published from time to time a large number of research studies in cotton, including the late Prof. M.L.Dantwala's unforgettable masterpiece "A Hundred Years of Indian Cotton" brought out on the occasion of the Silver Jubilee of the Cotton Exchange in 1947. This was followed by "Saga of the Cotton Exchange" released to commemorate the Diamond Jubilee year of the Association in 1981. These two publications, together with the present one, probably constitute the trilogy covering the history of Indian cotton during the last over century and a half.

The other major publications of the Cotton Exchange include "Indian Cotton – Today and Tomorrow". "King Cotton", "State Intervention in Cotton", "Glimpses of World Cotton", "Towards Free Cotton Trade", "Cotton Miles to Go" "National Cotton Board of India" and "Towards Development of Commodity Exchanges", besides a large number of brochures and pamphlets covering various aspects of production, marketing and futures trading in cotton. All these publications have served the cotton community and also enlightened the non-cotton interests in academic and other circles.

The Cotton Exchange has recently developed two websites. All the important data and information pertaining to cotton and the Association are available on real time basis to the cotton fraternity and others in India, as also throughout the world on one of these. The other one covers exclusively futures trading operations and provides facilities for on-line trading. The Cotton Exchange has thus entered the New Era of Information Technology with the dawn of the 21st Century.

National Cotton Board

It was in June 1994 that the then dynamic President of the East India Cotton Association, Mr. Chandrasinh Mirani, mooted a novel and prescient idea of setting up a National Cotton Board of India comprising eight major segments of the Indian cotton industry, namely (1) cotton growers, (2) farm input suppliers, (3) ginners and bale pressers, (4) marketmen, (5) warehousemen, (6) spinners and weavers, (7) cotton co-operatives and (8) cottonseed crushers. The interests of these different segments do not often converge. But Mr. Mirani realised that if matters relating to all the segments of the cotton industry were to be handled effectively for strengthening the Indian cotton economy, it was imperative to set up a national level organization of these different segments to resolve amicably their conflicting interests. The concept of the National Cotton Board of India was born out of this imperative need.

The mission of the proposed National Board would be to function as a unifying umbrella organization for all the segments of the cotton industry to iron out their differences, overcome their weaknesses and work steadfastly towards the common goal of making the Indian cotton economy strong and competitive in the fibre and textile markets in India and abroad. The Board would develop a harmonious approach through co-ordination of all the cotton segments to strengthen the Indian cotton industry in order that it forges ahead in the post-WTO (World Trade Organization) era of stiff competition, while safeguarding simultaneously the legitimate interests of each segment. After all, the age-old maxim of "united we stand, divided we fall" holds good for the diverse cotton segments also. Instead of striving to survive at each other's cost and in the process cut one another's throat, they all must seek to grow together collectively and in a concerted manner. That way would be all to the good for all.

The broad organizational structure, the management set up and the functional objectives of the proposed National Cotton Board of India were worked out by the Cotton Exchange in consultation with the textile industry and brought out in a well thought out booklet entitled "National Cotton Board of India" in 1998. In his Presidential Address at the 77th Annual General Meeting of the Exchange held on August 25, 1999, Mr. Suresh Kotak earnestly appealed "to all cotton interests as well as the highest authorities in the government to give serious consideration to the setting up of a National Cotton Board of India". Let us hope that wiser counsels will prevail on the diverse cotton interests and it would not be long before the National Board takes shape and starts its work in earnest. The dream of Mr. Mirani and Mr. Kotak would then be realised to provide the Cotton Exchange with yet one more forum to serve King Cotton.

Platinum Jubilee Programmes

As the East India Cotton Association entered its Platinum Jubilee year in 1997, since it received formal recognition under the Bombay Cotton Contracts legislation enacted in 1922, the Association decided to celebrate its Platinum Jubilee during the cotton year 1997-98". Accordingly, the invocation of the Platinum Jubilee was celebrated at the hands of the then Union Minister for Textiles, Mr. R.L. Jalappa, at Mumbai on September 16, 1997.

In contrast to the earlier jubilee functions (such as the Silver Jubilee celebrated in 1947 and the Diamond Jubilee in 1985), the Cotton Exchange decided to celebrate its Platinum Jubilee by focusing on mainly the educational, research and policy aspects in cotton through organising inter-active "seminars" and intense discussions with experts on topical subjects at different centres in the major cotton producing regions of the country. It was also decided to prepare and release appropriate research publications and papers on these occasions.

The second meeting cum seminar of the Platinum Jubilee of the Association was held at Ahmedabad with the courtesy of the Ahmedabad Cotton Merchants Association on October 21, 1997. Mr. Sanat Mehta, M.P. was the Chief Guest, while Mr. V.B. Patel, President, All India Co-operative Cotton Federation Ltd. and Mr. Samveg A. Lalbhai, President, Gujarat Chamber of Commerce and Industry, were the Guests of Honour. A large number of cotton merchants, ginning and pressing factory owners, representatives and farmers' co-operative unions in Gujarat as well as many textile mill magnets participated in the meeting.

(To be continued....)

UPCOUNTRY SPOT RATES

(Rs./Qtl)

Sr. No.	Growth	Grade Standard	Grade	Staple	Micronaire	Strength /GPT	Spot Rate (Upcountry) 2018-19 Crop April 2019 8th	9th	10th	11th	12th	13th
	Standard Descriptions with Basic Grade & Staple in Millimetres based on Upper Half Mean Length [By law 66 (A) (a) (4)]											
1	P/H/R	ICS-101	Fine	Below 22mm	5.0-7.0	15	11867 (42200)	11810 (42000)	11754 (41800)	11754 (41800)	11782 (41900)	H
2	P/H/R	ICS-201	Fine	Below 22mm	5.0-7.0	15	12007 (42700)	11951 (42500)	11895 (42300)	11895 (42300)	11923 (42400)	
3	GUJ	ICS-102	Fine	22mm	4.0-6.0	20	10208 (36300)	10179 (36200)	10123 (36000)	10123 (36000)	10151 (36100)	
4	KAR	ICS-103	Fine	23mm	4.0-5.5	21	11529 (41000)	11501 (40900)	11445 (40700)	11445 (40700)	11473 (40800)	O
5	M/M	ICS-104	Fine	24mm	4.0-5.0	23	11979 (42600)	11951 (42500)	11895 (42300)	11895 (42300)	11923 (42400)	
6	P/H/R	ICS-202	Fine	26mm	3.5-4.9	26	12963 (46100)	12907 (45900)	12851 (45700)	12823 (45600)	12851 (45700)	L
7	M/M/A	ICS-105	Fine	26mm	3.0-3.4	25	11726 (41700)	11698 (41600)	11642 (41400)	11614 (41300)	11642 (41400)	
8	M/M/A	ICS-105	Fine	26mm	3.5-4.9	25	12092 (43000)	12063 (42900)	12007 (42700)	11979 (42600)	12007 (42700)	
9	P/H/R	ICS-105	Fine	27mm	3.5.4.9	26	13104 (46600)	13048 (46400)	12991 (46200)	12963 (46100)	12991 (46200)	I
10	M/M/A	ICS-105	Fine	27mm	3.0-3.4	26	12007 (42700)	11979 (42600)	11923 (42400)	11895 (42300)	11923 (42400)	
11	M/M/A	ICS-105	Fine	27mm	3.5-4.9	26	12373 (44000)	12345 (43900)	12288 (43700)	12260 (43600)	12288 (43700)	D
12	P/H/R	ICS-105	Fine	28mm	3.5-4.9	27	13188 (46900)	13132 (46700)	13076 (46500)	13048 (46400)	13076 (46500)	
13	M/M/A	ICS-105	Fine	28mm	3.5-4.9	27	12654 (45000)	12626 (44900)	12570 (44700)	12541 (44600)	12570 (44700)	
14	GUJ	ICS-105	Fine	28mm	3.5-4.9	27	12795 (45500)	12766 (45400)	12710 (45200)	12682 (45100)	12710 (45200)	A
15	M/M/A/K	ICS-105	Fine	29mm	3.5-4.9	28	12879 (45800)	12851 (45700)	12795 (45500)	12766 (45400)	12795 (45500)	
16	GUJ	ICS-105	Fine	29mm	3.5-4.9	28	12991 (46200)	12963 (46100)	12907 (45900)	12879 (45800)	12907 (45900)	Y
17	M/M/A/K	ICS-105	Fine	30mm	3.5-4.9	29	13160 (46800)	13132 (46700)	13076 (46500)	13048 (46400)	13076 (46500)	
18	M/M/A/K/T/O	ICS-105	Fine	31mm	3.5-4.9	30	13357 (47500)	13329 (47400)	13273 (47200)	13244 (47100)	13273 (47200)	
19	A/K/T/O	ICS-106	Fine	32mm	3.5-4.9	31	13638 (48500)	13610 (48400)	13554 (48200)	13526 (48100)	13554 (48200)	
20	M(P)/K/T	ICS-107	Fine	34mm	3.0-3.8	33	15888 (56500)	15860 (56400)	15803 (56200)	15775 (56100)	15803 (56200)	

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