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Challenges and Pathways in Making Mechanical Harvesting of Cotton A Reality

EXPERT's Column

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Major types of mechanisms involved in harvesting of cotton were suction or mechanical type. Mechanical picking mechanisms involved brush type, pin & finger type, spindle type, beater type, auger type, bristle type, tooth picking and saw type. Spindle type mechanism was found to be successful in picking seed cotton in Europe and American countries. Presently, spindle type cotton mechanism is mostly used by mechanical cotton pickers across most cotton producing countries. However, another system known as cotton stripping became popular wherever Ultra Narrow Row cotton cultivation is practiced. Stripper type harvesters are positioned as suitable to small holder farms which are dominant across Asia and countries like Argentina. The past two decades have seen efforts being made by public as well as private establishments to popularise mechanised cotton picking in India. Although, significant improvements have been made and many of the constraints removed over the years, large scale adoption still eludes the cotton ecosystem. This paper presents the evolution of the picker technology development in India and discusses ways to overcome challenges and suggests pathway to be followed to realise this goal.

Cotton is cultivated in three distinct agro-ecological regions (North, Central and South) of the country. Approximately 65 percent of India's cotton is produced on dry land and 35 percent on irrigated land. Small holdings, complex land tenure arrangement and excessive

farm fragmentation, further limit the scope for sophisticated farm power system more suited to large land holdings of North Zones. In small and marginal farms, except for tillage, other operations such as sowing, weeding, cotton picking harvesting and stalk uprooting are normally performed using animate sources of power. Though, India has an abundant labour force in agriculture, non-availability of manpower during peak crop season is a growing problem.

Cotton harvesting in India is done manually whether it is rainfed or irrigated and it is a highly labor-intensive operation. Manual picking is not only tedious but amounts to more than 35% of the labour used in cotton cultivation. Due to non-availability of labor in time, cotton picking gets delayed causing around 15 per cent field loss and affecting the overall quality of cotton lint. The change in weather forces the farmers to harvest cotton quickly and non-availability of labour and less available time makes it an expensive and complex process.

Adopting mechanical cotton picking, therefore, was felt necessary as early as 1972, when efforts were made by CCSHAU, Hissar, to develop a knapsack vacuum cotton picker. A laboratory model of blower fan for creating vacuum in the picking zone for the development of a pneumatic cotton picker was fabricated. However, further work could not be taken up as the model ended up picking up a lot of trash. Muthamiselvan et al. (2007) developed a knapsack cotton picker, however, the rate of work was found dismally low. It was, therefore, evident that any system that picked one boll at a time was more labour intensive than a human picker. This is the reason the hand-held pickers which were introduced in the Indian market at a later date, did not gain popularity.

Efforts to Introduce Spindle Type Cotton Picker in India

In 2003-04, a study was conducted on the performance of an imported John Deere 9935 two-row self-propelled cotton picker at different locations in India under NATP Project on "Adoption and refinement of a cotton picker and cleaning system". The performance of the cotton picker was evaluated at PAU Ludhiana and CICR, Nagpur. Tests at PAU, Ludhiana were conducted on LH 1556 having an average plant height of 112.9 cm. The mean values of forward speed, effective field capacity, total harvesting loss, mechanical picking efficiency and picker efficiency were 2.62 kmph, 0.28 ha/h, 23.62 %, 75.7 % and 76.4 %, respectively. The field evaluation of cotton picker at CICR, Nagpur was conducted on seven varieties/genotypes, namely CNH 120 MB, CNH 123, CNH 155, CNH 911, CNH 2713, CNH 4736 and GSH 2. The average height of plant and lowermost boll were 85.9 cm, 86.0 cm, 98.1 cm, 81.9 cm, 73.2 cm, 77.8 cm and 86.3 cm and 9.0 cm, 10.9 cm, 21.6 cm, 11.6 cm, 16.4 cm and 12.3 cm for CNH 120 MB, CNH 123, CNH 155, CNH 911, CNH 2713, CNH 4736 and GSH 2, respectively. The mean values of forward speed, effective field capacity, fuel consumption, total harvesting loss, mechanical picking efficiency and picker efficiency were 2.20-3.38 kmph, 0.278-0.563 ha/h, 22.0 - 24.0 l/h, 14.29-31.74 %, 55.6 - 83.1 % and 68.3-85.7 %, respectively. Trash content in the machine picked cotton was found to be 22-26 %. The cultural practices and staggered blooming characteristics of Indian cotton varieties and hybrids posed a great hinderance to mechanised cotton picking.

Pathway For Adoption Of Mechanical Harvesting In The Current Scenario

A brain storming session was organised by ICAR-CICR, Nagpur on World Cotton Day (7th October 2021), to chalk out a plan to address the challenges in promoting mechanical harvesting with the participation of public sector researchers from ICAR-CICR, ICAR-CIAE, ICAR-CIRCOT; Seed industry (Rasi Seeds); Agro-chemical majors: Bayer Crop Science (defoliants); Machinery industry: John Deere, Shaktiman Industries (cotton pickers), robotic harvester start-ups (Grobomac); Bajaj Steel (pre-cleaning machinery). The following points emerged from the panel discussion on mechanical harvesting of cotton in India:

- Cotton hybrids/varieties amenable for mechanisation as well as high density planting system (HDPS) and early bursting of bolls with synchronised boll opening should be developed using genetic engineering on PPP basis involving ICAR-CICR and seed producing companies.

- Non-availability of suitable plant growth regulators and defoliants was a major constraint in mechanisation. Efforts should to be made to develop it indigenously in collaboration with private industry.

- Pneumatic planters work well in sandy loam soils prevalent in Northern India, however, the same do not perform well in heavy black soils mostly prevalent in Central and Southern India. This is mainly because of the stickiness of the black soil, especially during rainfall. It was thus necessary to develop/refine the existing planters for working on wet soils. CICR and CIAE would work together in tandem with the stakeholder to find out the solution for the same.

- Strengthen extension services to educate the farmers to adopt complete mechanisation in cotton.

- Technology / machinery developed for cleaning and ginning of mechanically harvested cotton to be adopted and further refined and optimised to bring down the trash content to the acceptable level of 4-5%.

- To promote mechanical harvesting, at least one ginnery in each cotton growing state with additional machinery required for processing mechanically harvested cotton should be established with financial assistance from Technology Mission on Cotton (phase II).

- ICAR-CICR, CIRCOT, CIAE and other institutes to continue the on-going research in cotton mechanisation.

Consequently, a series of measures were initiated by ICAR-CICR along with the stakeholders to address the identified constraints and pave the way for mechanical harvesting of cotton in India. The following sections illustrate the measures taken in this direction.

High Density Planting System (HDPS)

ICAR-Central Institute for Cotton Research has developed, standardised and conducted large scale demonstrations on 'High Density Planting System' (HDPS) technology package suitable for machine picking. Cotton varieties and hybrids (both Bt and non-Bt seed types) were evaluated under HDPS for their compactness and amenability to mechanical picking with and without the plant growth regulator (Mepiquat Chrolide) at Nagpur, Sirsa and Coimbatore regional stations of ICAR-CICR. Several compact type genotypes were released by ICAR-CICR suitable for mechanical harvesting under HDPS (Fig. 1a)

Central Zone, Nagpur Centre: The promising compact hybrids identified under deep soils in Central Zone were, RCH608, SP7149, Ajeet 5 and varieties namely, ADB39, CO17, which had plant height around 100 cm and canopy width of 50 cm. All the hybrids and varieties evaluated were found to be compact after the application of mepiquat chloride (25 g a.i./ha) sprayed twice at 45 and 65 days.

	CICR-H Bt Cotton 60 (Yugank Bt)	CICR-H Bt Cotton 61 (Tejas Bt)	CICR-H Bt Cotton 62 Namami Bt)	CICR-H Bt Cotton 63 (Samrat Bt)
Ginning %	*38.1*	*36.3*	*38.2*	*36.7*

Fig 1b: Demonstration of compact genotypes

North Zone, Sirsa Centre: Thirteen cotton genotypes were tested under HDPS (spacing 90 x 15 cm). RCH-926and RCH 773 BG-II hybrids, PAU Bt-3 and CSH-3075 among varieties were found promising in terms of compactness and higher yields with plant growth regulation.

South Zone, Coimbatore Centre: Five non-Bt varieties (Suraksha, Subhiksha, Suraj, Nano, Co-17) and three BG II hybrids (RCH 608, NCS 2778 and RCH 578) were evaluated for compactness during kharif 2022. The varieties were planted at 90 x 10cm spacing and hybrids were planted at 90 x 15 cm spacing. Among varieties, Nano produced the highest seed cotton yield with mepiquat chloride application and the height of lower most boll was 18 cm from ground surface. Among hybrids, RCH 608 BG II recorded the highest seed cotton yield. However, RCH 578 BG II recorded better ground clearance for machine picking as the height of lower most boll was 23cm.

Under the Special Cotton Project, "Targeting technology to agro-ecological zone large scale demonstrations of 14 HDPS Compact genotypes in 8 states covering 52 districts in an area of 3000 ha has been conducted (Fig 1b)".

Plant Growth Regulator (PGR)

PGR is used in cotton to regulate vegetative growth of the plant, to reduce plant height and ensure better harvest index. Optimum use of Nitrogen coupled with use of PGR will facilitate machine picking. Several PGRs such as Livosin, cycocel, etc. are available in the market. It can be used once or multiple application during the flowering period to reduce plant height and improve yield through higher fruit retention. While reduction in growth following cycocel treatments was observed by all workers, improvement in yield also was noted by many (Basu et. al. 1979). More potent PGRs are likely to be available in future. In a trial of evaluation of defoliants and growth regulators at ICAR-CICR, Subiksha and Suraksha among varieties and CH 578 BGII among hybrids outperformed the rest in terms of compactness and height of lowermost boll, with the application of mepiquat chloride growth regulator.

Defoliation

Use of defoliant is inevitable for efficient and trash free picking of cotton by mechanical harvester. Mechanical picking of cotton with spindle type picker has to be preceded with chemical defoliation of cotton plants since leaves add to the trash content which downgrade the quality of cotton. At present there are no registered defoliants available in India. There is need for a better defoliant to ensure more defoliation prior to machine picking with minimum trash content. ICAR-CICR, Nagpur is testing a defoliant chemical formulation over two seasons. Among the defoliants tested in the North Zone, application at 7 days interval resulted in highest number of fully opened bolls per plant (28.0), boll opening percentage (97.3%) and defoliation percentage (92.6%) (Fig 2).

Fig. 2: Testing of defoliants in cotton

For machine harvesting at Coimbatore centre, ICAR-CICR defoliant was sprayed when the crop was 140 days old and desired level of boll opening and defoliation was achieved, outperforming the commercially available salts. However, apart from on-going research, concerted efforts are needed to rope in agro-chemical input firms for registering proven and effective defoliant chemical(s) for commercial use on cotton in the country at the earliest to facilitate mechanical cotton picking.

Plant, soil and environmental (temperature and humidity) conditions also play a critical role in the effectiveness of defoliation and resultant level of trash content in mechanically harvested cotton. Genotypes with less leaf biomass, avoiding excessive plant stress, prevalence of night temperatures above 20^{O}C are some critical factors. Performance of the defoliant will be more evident when used under ideal environmental conditions.

It is high time that such cotton growing locations of sizeable area are identified in different states and the complete package comprising of mechanical sowing at high density, nutrient management (need based N application), crop growth regulation with PGR, and defoliant application in right conditions is done for mechanical harvesting of cotton with commercially available two row spindle type pickers and picked cotton is tested for trash content before and after pre-cleaning and post-cleaning at the ginnery. Such effective defoliants need to be registered for commercial use and their availability ensured for realising the potential.

Performance Of Spindle Type Picker In Cotton Variety Suraksha

At Coimbatore Regional Station of ICAR-CICR, 150 days old cotton variety Suraksha under HDPS system (90 x 10 cm spacing) in one-hectare was harvested using Shaktiman Cotton Master 1437 Spindle type two row picker (Fig 3). The field capacity of the picker was one acre per hour. The total trash content in the harvested kapas ranged from 8.96 -12.44% on seed cotton basis (Fig 4). On seed cotton basis, dried/ green leaves, bracts/ burrs and sticks contributed 5%, 2.9% and 0.6% of mean trash content, respectively.

Trash Content in Machine Picked Cotton

Ginning factories are most crucial for success or otherwise of machine picked cotton in India because it is here that most trash of the machine

Fig.3: ICAR-CICR cotton variety Suraksha being harvested using two row spindle type cotton picker

Fig 4: Trash constituents in machine picked

picked cotton will be eliminated. Thousand (869) ginning factories of India have been modernised with pre-cleaner and post-cleaner under Technology Mission of Cotton (Mini Mission IV). Additional pre and post-cleaners specific for machine picked cotton will have to be installed in the ginning factories with support under a phase II of TMC. Testing equipment (HVI) installed at the ginning factories will further establish the fibre quality of machine picked cotton. These changes will eventually pave way for lint-based marketing of quality cotton and result in a win-win situation for producers and downstream players.

Conclusion

Scarcity of labour and therefore, the higher cost of picking seed cotton and consequent higher cost of cultivation will eventually pave the way for mechanical harvesting of cotton in India. Cotton is grown in all categories of land holdings and under all sources of power. Therefore, cotton harvesters will need to come in all shapes and sizes, harnessing the available power to satiate the demands of Indian cotton. Many of the constraints and bottlenecks faced while popularising the earlier cotton pickers have now been adequately addressed to pave the way for wider adaptability of the picker. With the advent of new genotypes, it may be possible to introduce mechanical cotton pickers successfully. The trash content in the machine picked cotton has significantly reduced from earlier 20% to 10-12% and the efficiency of picking has gone up from 85 to 95%.

The pathway for mechanication of cotton harvesting entails meeting three essential requirements now:

- Scaling up of HDPS, a global best practice, in suitable growing environments with amenable early maturing compact genotypes grown at prescribed spacing and canopy management with use of PGRs (available commercially) to facilitate single picking of cotton.

- Availability and use of registered defoliant chemicals to aid clean picking of cotton.

- Pre-cleaning to reduce trash content in machine picked cotton to acceptable level at farm gate to ensure realisation of market price by farmers and post-cleaning at ginnery to further improve quality to suit market demand.

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

CAI Celebrates Maghi Ganesh Jayanti

On the occasion of Maghi Ganesh Jayanti, on Tuesday, the 13th February 2024, Cotton Depot Shree Ganeshotsav Trust organised a "Maha Aarti of Lord Ganesha" on the Ground Floor of Cotton Exchange Building, Cotton Green, followed by Tirtha Prasad. The Maha Aarti was attended by CAI President Shri. Atul S. Ganatra, CAI office bearers and members


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A CHILD'S CHILDHOOD IS FOR LEARNING
DON'T USE THEIR CHILDHOOD FOR EARNING
SAY NO TO CHILD LABOUR

UPCOUNTRY SPOT RATES

(Rs./Qtl)

Sr. No.	Growth	Grade Standard	Grade	Staple	Micronaire	Gravimetric Trash	Strength /GPT	Spot Rate (Upcountry) 2022-23 Crop February 2024 12th	13th	14th	15th	16th	17th
4	KAR	ICS-103	Fine	22mm	4.5 – 6.0	6%	21	14060 (50000)	14060 (50000)	14144 (50300)	14341 (51000)	14341 (51000)	14341 (51000)
								Spot Rate (Upcountry) 2023-24 Crop					
1	P/H/R	ICS-101	Fine	Below 22mm	5.0 – 7.0	4%	15	12879 (45800)	12879 (45800)	12879 (45800)	12907 (45900)	12907 (45900)	12907 (45900)
2	P/H/R (SG)	ICS-201	Fine	Below 22mm	5.0 – 7.0	4.5%	15	13048 (46400)	13048 (46400)	13048 (46400)	13076 (46500)	13076 (46500)	13076 (46500)
3	GUJ	ICS-102	Fine	22mm	4.0 – 6.0	13%	20	10461 (37200)	10573 (37600)	10826 (38500)	11135 (39600)	10967 (39000)	10967 (39000)
5	M/M (P)	ICS-104	Fine	23mm	4.5 – 7.0	4%	22	14960 (53200)	14960 (53200)	15044 (53500)	15100 (53700)	15100 (53700)	15100 (53700)
6	P/H/R (U) (SG)	ICS-202	Fine	27mm	3.5 – 4.9	4.5%	26	14679 (52200)	14622 (52000)	14622 (52000)	14735 (52400)	14847 (52800)	14847 (52800)
7	M/M(P)/ SA/TL	ICS-105	Fine	26mm	3.0 – 3.4	4%	25	- -	- -	- -	- -	- -	- -
8	P/H/R(U)	ICS-105	Fine	27mm	3.5 – 4.9	4%	26	14847 (52800)	14791 (52600)	14791 (52600)	14904 (53000)	15016 (53400)	15016 (53400)
9	M/M(P)/ SA/TL/G	ICS-105	Fine	27mm	3.0 – 3.4	4%	25	13807 (49100)	13807 (49100)	13835 (49200)	14060 (50000)	14144 (50300)	14144 (50300)
10	M/M(P)/ SA/TL	ICS-105	Fine	27mm	3.5 – 4.9	3.5%	26	14566 (51800)	14566 (51800)	14594 (51900)	14904 (53000)	14988 (53300)	14988 (53300)
11	P/H/R(U)	ICS-105	Fine	28mm	3.5 – 4.9	4%	27	15044 (53500)	14988 (53300)	14988 (53300)	15100 (53700)	15213 (54100)	15213 (54100)
12	M/M(P)	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27	15438 (54900)	15466 (55000)	15494 (55100)	15663 (55700)	15719 (55900)	15719 (55900)
13	SA/TL/K	ICS-105	Fine	28mm	3.7 – 4.5	3.5%	27	15494 (55100)	15522 (55200)	15550 (55300)	15719 (55900)	15775 (56100)	15775 (56100)
14	GUJ	ICS-105	Fine	28mm	3.7 – 4.5	3%	27	15775 (56100)	15775 (56100)	15832 (56300)	16000 (56900)	16113 (57300)	16113 (57300)
15	R(L)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28	15353 (54600)	15353 (54600)	15382 (54700)	15550 (55300)	15663 (55700)	15663 (55700)
16	M/M(P)	ICS-105	Fine	29mm	3.7 – 4.5	3.5%	28	15691 (55800)	15719 (55900)	15747 (56000)	15972 (56800)	16028 (57000)	16028 (57000)
17	SA/TL/K	ICS-105	Fine	29mm	3.7 – 4.5	3%	28	15747 (56000)	15775 (56100)	15803 (56200)	15972 (56800)	16085 (57200)	16085 (57200)
18	GUJ	ICS-105	Fine	29mm	3.7 – 4.5	3%	28	15944 (56700)	15944 (56700)	16000 (56900)	16169 (57500)	16281 (57900)	16281 (57900)
19	M/M(P)	ICS-105	Fine	30mm	3.7 – 4.5	3.5%	29	15888 (56500)	15916 (56600)	15944 (56700)	16113 (57300)	16169 (57500)	16450 (58500)
20	SA/TL/K/O	ICS-105	Fine	30mm	3.7 – 4.5	3%	29	15944 (56700)	15972 (56800)	16000 (56900)	16169 (57500)	16225 (57700)	16506 (58700)
21	M/M(P)	ICS-105	Fine	31mm	3.7 – 4.5	3%	30	16113 (57300)	16113 (57300)	16141 (57400)	16310 (58000)	16366 (58200)	16591 (59000)
22	SA/TL/ K / TN/O	ICS-105	Fine	31mm	3.7 – 4.5	3%	30	16169 (57500)	16169 (57500)	16197 (57600)	16366 (58200)	16422 (58400)	16647 (59200)
23	SA/TL/K/ TN/O	ICS-106	Fine	32mm	3.5 – 4.2	3%	31	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)	N.A. (N.A.)
24	M/M(P)	ICS-107	Fine	34mm	2.8 - 3.7	4%	33	22355 (79500)	22355 (79500)	22355 (79500)	22637 (80500)	22637 (80500)	22637 (80500)
25	K/TN	ICS-107	Fine	34mm	2.8 - 3.7	3.5%	34	22777 (81000)	22777 (81000)	22777 (81000)	23058 (82000)	23058 (82000)	23058 (82000)
26	M/M(P)	ICS-107	Fine	35mm	2.8 - 3.7	4%	35	22777 (81000)	22777 (81000)	22777 (81000)	23058 (82000)	23058 (82000)	23058 (82000)
27	K/TN	ICS-107	Fine	35mm	2.8 - 3.7	3.5%	35	23340 (83000)	23340 (83000)	23340 (83000)	23480 (83500)	23480 (83500)	23480 (83500)

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