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Impact and gap analysis of HDPS in cotton in Khammam District of Telangana

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Abstract

High-density Planting System in cotton is one of the breakthrough technologies for maximising yields in Khammam district of Telangana. To create awareness among the farmers, the large scale demonstrations were carried out during Kharif season in the year 2023-24, 2024-25, 2025-26 season under Krishi Vigyan Kendra, Wyra & ICAR-CICR, Nagpur Special Cotton Project entitled "Targeting Technologies to Agro-Ecological Zones - Large Scale Demonstrations of Best Practices to Enhance Cotton Productivity" under NFSM, in the Khammam district of Telangana. It was to evaluate the effectiveness of HDPS, and the results provide insights on yield and Cost economics of HDPS and traditional cotton farming practices gaps between the recommended package of practices and farmers' practice. The results showed that the average yields of the last three years were found to be 11.41 and 7.73 in HDPS and traditional method of Cotton cultivation respectively. Additionally, every year there is an increase in the yield of 35.2%, 89% and 31% in 2023-24, 2024-25, 2025-26 correspondingly.

Keywords: High-density planting system, cotton productivity, Krishi Vigyan Kendra, demonstration trials

Introduction

Cotton is one of the most important fibre and cash crops of India and plays a pivotal role in the industrial and agricultural economy of the country. It provides cotton fibre to the cotton textile industry. Cotton in India provides direct livelihood to 6 million farmers and about 40 -50 million people are employed in cotton trade and its processing.

Cotton is an immensely important crop for the sustainable economy of India and livelihood of the farming community. It is cultivated in about 312 lakh hectares across the world and in around 117 lakh hectares in India. Thus, India accounts for around 37.5% of the global cotton area and contributes to 26% (i.e. 6.20 Million MT) of the global cotton produce of 23.92 Million MT. Cotton is pre-eminent and the most adored fibre among the Indian textile mills, as the major raw material for the textile industry. The Southern Zone (which comprises states like Telangana, Andhra Pradesh, Karnataka, and Tamil Nadu) is the second biggest

producer of cotton, producing about 28.5% of the nation's cotton, with Telangana producing the largest in the Southern Zone and the third largest in the country, contributing 5.31 million bales (bales of 170 kg each). Additionally it is largest contributors to India's foreign exchange by exports in the form of raw cotton and products such as yarn and fabrics to finished products in the form of garments etc. Besides lint, India also produces about 1.2 millions tonnes cotton seed oil every year as a by product due to its economic importance cotton is considered as white gold. Though Telangana has large area under cotton, but the farmers encountering challenges with low yields eventually with less income. Hence to boost the productivity in cotton and enhance the income among cotton, the scientist identified suitable and best improved technology High Density Planting System for Telangana farmers.

Cotton is predominantly cultivated under rainfed conditions in Telangana in shallow to medium deep soils in traditional

method of cultivation incurring low yield. High density planting system, thus the most appropriate technology to target such area for enhancing the productivity. A special project on cotton, funded by the Ministry of Agriculture and Farmers Welfare and implemented by ICAR-CICR, Nagpur in 8 States across 57 districts, 286 clusters covering more than 9000 ha area and 10000 farmer beneficiaries. Adoption of high-density planting system has shown to increase productivity in shallow to medium soils in Maharashtra, Telangana, Andhra Pradesh, Karnataka and light soil areas in Gujarat (Venugopalan *et al.*, 2013) [6]. In other countries adopting HDPS, with high seed rate of variety is used (12-15 kg/ha) at a higher density resulting in plant population of over 1,11,000 plants/ha. In India, conventionally, hybrids seeds are planted at a seed rate of 2 packets (450 g each of Bt cotton seed) at a spacing of 90 cm row to row and 60 cm plant to plant spacing per acre resulting in a plant population of 4938 plants/acre. In HDPS, higher seed rate (5-6 seed packets/ac) is used for sowing at a spacing of 90 x 15 cm resulting in a plant population of 29629 plants/acre. Early to medium maturing, compact hybrids are used, canopy management of plant is supported by plant growth regulator to render the plants compact under rainfed conditions so that plants have reduced internodal distance and height. Each plant is expected to bear 8-12 bolls per plant and mature synchronously, harvested in one-two pickings. HDPS cotton is suitable for machine picking, currently, farmers are spending 32% of labour cost on manual picking of cotton. Because of longer duration, these varieties require more number of pickings which warrant increased labour and fluctuating prices resulting in lesser realistic income. This study aims to elucidate the significant yield disparities observed between High-Density Planting System cotton in demonstration plots and that conventional farmer's practices. HDPS cotton exhibited a shorter crop duration of 150 days, compared to the traditional cotton's 180 days,

enabling quicker harvesting, extricating incidence of pink boll worm that would have appended the cost of cultivation, additionally shorter growing season allows farmers to cultivate a second crop such as green gram, black gram, maize, sesame, enhancing overall farm productivity and income. In contrast, the longer duration of traditional cotton limits the opportunity to grow a second crop in the same season, incidence of pink boll worm may increase cost of cultivation and subsidize the productivity. In terms of yield, HDPS cotton achieved 12-14 quintals per acre in light red soils, whereas traditional cotton produced 6-7 quintals per acre. Additionally, HDPS cotton required fewer pickings (1-2) compared to traditional cotton (3-4), reflecting its faster maturation. While the number of pickings may be lower, the overall yield potential is higher for HDPS due to the increased plant population, which compensates for the fewer pickings.

Materials and Methods

The study was conducted in Khammam district of Telangana state. Demonstrations conducted in various locations selected from 2023-24 to 2025-26 during Kharif (June-October) in different blocks under Krishi Vigyan Kendra, Wyrā in Khammam district. Demos were conducted along with check plot and they were taken into consideration for the study to find out the impact of HDPS demonstrations among cotton farmers for enhancing productivity. Each demonstration was conducted by the respondent farmers with improved recommended practices for HDPS in red soils or light soils such as 2 kg seed rate per acre, HDPS spacing 90 x 15 cm, spraying of plant growth regulator Mepiquat chloride @ 45, 60 and 75 days after sowing based on plant height and growth. The demo plot of demos acted as farmers practice.

Results

Table 1: Yield and Cost economics of Demonstrations on High Density planting system in Cotton

Year	Yield (kgs acre)		Gross expenditure acre (₹)		Gross returns acre (₹)		Net Returns (₹) acre		B: C ratio	
	90*30 cms	90*60 cms	90*30 cms	90*60 cms	90*30 cms	90*60 cms	90*30 cms	90*60 cms	90*30 cms	90*60 cms
2023-24	11.5	6.5	41650	34950	72820	43030	31170	29790	1.74	1.23
2024-25	13.8	7.3	43578	28800	98269	51100	54691	22300	2.25	1.77
2025-26	8.95	6.8	49775	44700	69000	52428	19225	7728	1.38	1.17
Average	11.41	7.73	45001	22740	64696.3	43162	35028	16.012	1.79	1.37

Yield and Economic parameters

The perusal of data (Table 1) indicate that average HDPS cotton yield from 11.5 q/ acre, 13.8 q/acre, 8.95 q/acre in demonstration plots and 6.5 q/ acre, 7.3q/acre to 6.8 q/ acre in farmer's practice in 2023-2024, 2024-2025, 2025-2026 respectively. An average yield of 11.4 q/ acre was obtained under demonstration plots as compared to farmer's practice plots yield 7.73 q/acre consecutively. These results clearly indicate that the higher average yield was obtained in demonstration plots over the years compared to farmer's practice due technological interventions. These findings line

with results of Saritha *et al.* (2024) [2]. Economic analysis of the yield performance from Table 1 showed that benefit cost ratio of demonstration plots was observed to be significantly higher than farmer's practice. The benefit cost ratio of recommended and control plots were recorded as 1.74, 2.25 and 1.38 compared to 1.23, 1.77 and 1.17 during 2022-23, 2023-24 and 2024-25 respectively. The accumulated results of technological interventions over three years, revealed an average benefit cost ratio of 1.79 in demonstration plots compared to 1.37 in control plots. High BC ratio during 2024-25 is due to high procurement price of cotton.

Table 2: Impact on Yield due to High Density Planting System in Cotton

Year	Demonstration plot (quintals /acre)	Control plot (quintals /acre)	Change in yield (q/acre)	Impact (% Change)
2023-24	11.5	6.5	5	76.9
2024-25	13.8	7.3	6.5	89
2025-26	8.95	6.80	1.31	31
Average	11.41	6.1	5.31	65.3

It can be noted from Table 2 that yield change noticed due to High Density Planting System Demos in Cotton were 5, 6.5 and 1.31 q acre during 2023-24, 2024-25, 2025-2026

respectively. The average change in the yields 5.31. The average percent change in yield observed was 65.3. The results are in tune with the results of Madhushekhar.

Table 3: Gap analysis between recommended package of practices and farmer's practice on High Density planting system in Cotton

S. No	Technology Interventions	Recommended practice	Farmers practice	Remarks
Selection of cultivars for HDPS				
1	Cultivars with compact, short fruiting branches, early maturing, synchronous boll bursting with higher retention of first position bolls and big boll size (>4 g) should be selected.	The hybrids or cultivators suggested for HDPS are sown by the farmers.	Partially adopted	78% adoption
Pre-sowing operations				
2	Deep summer ploughings	Completely adopted	Completely adopted	No Gap
3	Add well decomposed farm yard manure (FYM) @ 4 tonnes/acre at least 15 days before sowing	Partially adopted	Partially adopted	78%
4	2-3 harrowings after pre-monsoon showers	On receipt of rainfall field is cultivated to get good tilth	Adopted by many farmers	12%
5	Manual sowing may be taken up after receipt of rainfall	Sowing initiate after receiving monsoon	Sowing initiate after receiving monsoon	No gap
6	Use of pneumatic planter for sowing facilitating precision placement of seed at the right depth (5-6 cm)	The pneumatic planters sowings are practiced in few areas	Not adopted	89%
7	Manual sowings can be done by using marked rope, Gunter's chain, marked plastic pipes, length sticks etc. to maintain plant to plant distance (In case of non-availability of pneumatic planter) with hand measurement	Manual sowings with hand measurement	Partially adopted by the farmers	21.5% gap
8	Pre-emergence application of Pendimethalin 38.7% CS @ 700 ml/acre within 24-48 hours of sowing, post emergence application of Quisalofof ethyl 6% EC + Pyriothibac sodium 4% EC (combination product) @ 2.5 ml /lit	As inter cultivation could not be practiced due to less spacing, weedicides are profusely used	As inter cultivation could not be practiced due to less spacing, but weeding is practiced by hoeing operations	No Gap
9	Recommended dose for HDPS and closer spacing is 48:24:24 kg /acre (N:P:K).	Higher dose than recommended is followed	Indiscriminate use of fertilizers	87.6%
10	Basal or at time of sowing: 1/3rd N, full P and ½ dose of K; Squaring stage (40-45 days after sowing): 1/3rd N, ½ of K and 5 kg ZnSO ₄ ; Flowering and early boll formation stage (70-75 days after sowing): 1/3 rd N + 2 kg Boron	Higher dose fertilizers are followed but the doses of Boron and zinc is not practiced by the farmers until deficiency is observed	Indiscriminate use of fertilizers	73.5%
11	To limit vegetative growth, plant growth regulator (PGR) like mepiquat chloride is used 2-3 times. 1 st Spray (40-45 day crop or Square initiation or crop is 40-45 cm tall) @ 1 ml/lit; 2 nd Spray (15-20 days after 1 st spray) or 55 to 65 days crop @ 1.2 ml/lit; 3 rd spray (need based in case of excessive growth due to rains) or 80 days crop @ 1.2 ml/lit.	Spraying is adopted by the demo farmers	Not Adopted	100%
12	Install or erect pheromone traps at 45 days after crop sowing @ 4/acre for monitoring of pink boll worm.	No followed as the crop is terminated by the end of October end and November	Not adopted by the farmers	100%
13	Spray NSKE 5% or <i>Azadirachtin</i> (1500 ppm) @ 5 ml/l of water with surf or sandovit @ 1 ml/l of water as a prophylactic measure at 40-45 days of the crop.	Prophylactic spray adopted by the farmers	Partially adopted	76%
14	Crop is ready for 1 st picking after 130-135 DAS and 2 nd picking by 150-160 DAS.	Adopted	Partially adopted	93%
15	After the complete harvest of the crop, crop is shredded with tractor operated mobile cotton shredder	Adopted with Rotavator as cotton shredder is available with farmers, besides the cotton shredder needs 50 Hp tractor, that is difficult for the farmer to procure	Adopted but with Rotavator	0% gap
16	Terminate the crop between 150-160 days and go for second crop with green gram/ maize /sesamum /vegetables/melons etc.	The farmers in Khammam district go for second crop with green gram, Maize	The farmers in Khammam district go for second crop with green gram, Maize	No gap

The Gap between the Recommendations of Demo farmers and non demo farmer's practice in details are given in Table 3. Many farmers are following recommended package of practices in Cotton Cultivation with suitable changes as per the land and farmers suitability viz., Summer ploughings, 2-3 harrowings, maintaining 90*15 Spacings. Certain

Intervention like sowings pneumatic planter, erection of pheromone traps, spraying of Mepiquat chloride (PGR) shown huge adoption gap, owing to non-availability of cotton planter in all demo areas and farmers practice, furthermore the pneumatic planter has to be attached to 50 Hp tractor and many farmers are owing 45 Hp tractor.1

Manual planting by using marked rope, length sticks etc. to maintain plant to plant distance was not taken up by most of the farmers thus a gap of 21.5% was observed. Plant spacing between plant to plant in HDPS (90 x 15 cm) was practised with plus and minus difference in centimetres leading to a gap of 21.5%. Indiscriminate spraying of the insecticides was observed among farmers compared to demo farmers who monitored the pest and used prophylactic sprays with neem oil, hence a gap of 43.75%. The results are inline with the results of B Raja Madhu Shekhar. Plant protection, weed management and nutrient management aspects showed huge gaps in both demo and non demo farmers, as didn't follow the recommended practices, even demo farmers also practiced interventions fully which were easy and feasible hence partial adoption was seen. Regarding terminating the

cotton with shredder, it has to be attached in 50 hp tractor, as many farmers are own 45 hp tractor and is incompatible with cotton so the farmers are skeptical on usage has resulted in this gap. Rajib *et al.*, 2022 also observed similar differences in pest management. The above result of differences in recommended practices to farmers practice are in unity with the findings of Shekar *et al.*, 2021^[11] and Balai *et al.*, 2021^[3] who also reported similar findings in paddy and Mustard respectively

The insights gained from this study highlight critical areas where farmer education on pneumatic planter sowings and cotton shredder the policy intervention can bridge the existing adoption gaps in HDPS for cotton, ultimately fostering more sustainable and profitable cultivation practices.

Table 4: Comparative Cost incurred in different package of practices by the farmers

S. No	Package of practices	HDPS 90 *15 cm 2023-24	Conventional method 90*90 cm 2023-24	HDPS 90 *15 cm 2024-25	Conventional method 90*90 cm 2024-25	HDPS 90 *15 cm 2025-26	Conventional method 90*90 cm 2025-26
1	Land preparation	4500	5000	6000	2500	6500	8000
2	Seed and Sowing	5700	3450	6,600	2200	4400	2200
3	Gap filling	500	300	600	200	500	300
4	Total weeding	3900	9400	4300	3000	10,500	10000
5	Fertilizer	3260	3000	3937	3937	7500	7500
6	Pesticide	6000	5000	3550	4500	6500	6500
7	Chemical canopy management	1200	0	900	-	1200	0
8	Harvesting labour	16500	8800	17,691	12463-00	12675	10,200
9	Total cost of cultivation	41650	34950	43,578	28,800	49775	44700
10	Yield (kg)	1100	6.5	13.8	7.3	895	680
11	MSP2023-24per kg	6620	6620	71.21	71.21	7710	7710
12	Gross income	72820	43030	98269	51,100	69000	32428
13	Net income	31170	8080	54,691	22300	19225	7728
14	B:C	1.74	1.23	2.25:1	1.77:1	1.38	1.17

The cost of cultivation during the last three years are given The cost of inputs for components related to cultivation costs between 2023-24, 2024-2025, 2025-2026 respectively. Input costs for seed and sowing is more for three years, additional cost for canopy management time influenced a small rise in cost of cultivation compared to conventional practice. Nevertheless the due to increase in yields and net returns, this technology is extensively adopted by the farmers and a drastic shift has been witnessed in adoption of this practice.

Adoption of High density planting system - A breakthrough technology, helping in enhancing the yields in cotton

Shri. Chalamala Laxmaiah is a resident of Erlapudi Village, Raghunadapalem Mandal, Khammam District. The farmer is having 5 acres of land and practicing the farming from the last 21 years. In the total 5 acres of land, the famer used to cultivate the cotton under rainfed situation and witnessed reduction in yield of Bt cotton upto 35 to 40% due to infestation of pink bollworm since last 5 years.

The cost of cultivation increased due to intensive sprayings for management of pink boll worm and realised less profit. During 2025-26, the farmer cultivated cotton crop over same area under "Targeting technologies to agro-ecological zones- large scale demonstrations of best practices to enhance cotton productivity, funded by CICR, Nagpur with technical support and guidance from Scientists of KVK,

Wyra, Khammam".

Under the demonstration, KVK staff regularly provided the guidance by visiting fields at regular intervals during the entire season. The farmer followed all the practices like spraying of Chamatkar (Mepiquat Chloride) and terminated the crop by end of October to avoid pink bollworm incidence. In demonstration plot, farmer achieved a yield of 13.8 quintal from one acre whereas in conventional planting he got only 7.25 q/acre in the previous year. With the implementation of strategies included in Closer spacing the cotton yield was increased by 52.53% than conventional planting. Further, the technology also reduced the number of sprayings towards managing the pink bollworm. The farmer appreciated the KVK, staff for demonstrating the closer spacing technology and expressed thankfulness to the CICR, Nagpur for providing the inputs.

Conclusion

HDPS is salient technology to making cotton farming resilient and progressive. This technology is well proven in Khammam District for increasing productivity and reducing the risk in cotton cultivation, but need to create awareness on mechanization, develop suitable machinery that can avail the farmers with no or little modification, so that farmer can attach to the tractors as mechanization in cotton is essential due to shortage of labour. This is highly effective and transformative strategy for adopting and enhancing machine picking efficiency in cotton cultivation. High density

planting system significantly increases plant populations and optimises the utilization of land and resources, while the PGR, s properly regulates the vegetative growth, keeping compact and plant canopy for machine picking in future.

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