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E Ravi Goud
SHE&CS, Krishi Vigyan Kendra,
Yagantipalle, Banaganapalli (M),
Nandyal Dit., Andhra Pradesh,
India

G Dhanalakshmi
SS&H, SHE&CS, KVK,
Yagantipalle, Nandyal Dit.,
Andhra Pradesh, India

M Sudhakar
SMS (Agro.), SHE&CS, KVK,
Yagantipalle, Nandyal Dit.,
Andhra Pradesh, India

D Balaraju
SMS (PP), SHE&CS, KVK,
Yagantipalle, Nandyal Dit.,
Andhra Pradesh, India

S Srikanth
YP-II, Special project on cotton,
SHE&CS, KVK, Yagantipalle,
Nandyal Dit., Andhra Pradesh,
India

AR Reddy
Principal Scientist, ICAR-ATARI
Zone-X, Hyderabad, Telangana,
India

A Tayade
Head, Division of Crop Production,
ICAR-CICR, Nagpur,
Maharashtra, India

Corresponding Author:
E Ravi Goud
SHE&CS, Krishi Vigyan Kendra,
Yagantipalle, Banaganapalli (M),
Nandyal Dit., Andhra Pradesh,
India

HDPS cotton: A pathway for higher yields in rainfed situations

E Ravi Goud, G Dhanalakshmi, M Sudhakar, D Balaraju, S Srikanth, AR Reddy and A Tayade

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Abstract

The present study was carried out in Nandyal district of Andhra Pradesh with objective of trace the feasibility of HDPS method of cotton cultivation in rainfed situations during 2023-2024. This technology was promoted by ICAR-CICR, Nagpur under special project of cotton with PPP mode through private seed companies and 34 KVKs of six different states in the country since *Kharif* 2023. A descriptive research design was used to analyze the factors influencing cotton production. Data collection was carried out using a structured interview schedule, with 60 farmers purposively selected based on the demonstrations conducted from two years in 60 locations from three blocks: Nandikotkur, Midthur, and Jupadubung low of the district. The study indicated that average yield recorded 22.35q/ha in demonstration plot over control (18.25q/ha) and an average additional yield of 4.10q/ha with 23.75% of average yield increase over control plot. With a two-year average technology index of 36.14%, the technological gap was 12.65 q/ha, and the extension gap was 4.1 q/ha was recorded. The demonstrated plots gave higher net returns Rs. 93,845/ha with higher benefit cost ratio 1.82 compared to farmer's practice (1.12). Additionally, the Multiple Linear Regression analysis revealed that education, experience, and risk-bearing ability were the three independent variables that explained the majority of the variation in the adoption of HDPS practices among the demonstration farmers in the area, accounting 61.70 percent of the adoption variation among the HDPS cotton growers. In HDPS Cotton, maintaining accurate intra-row spacing was challenging with manual labor. This challenge was addressed by adopting a cost-effective manual push seed planter designed for specified area.

Keywords: HDPS, special project on cotton, technology index, multi linear regression

1. Introduction

Cotton is one of the important commercial crops and leading natural fiber in the world, cultivating by 100 countries in 33.16 million hectares which is accounting for 25.89 million tons. India is cultivating in 130.61 lakh hectares which is 40 per cent of world cotton cultivation area, producing 5.84 million tons with 23.84 per cent of world production and supporting millions of livelihoods and industries (Anonymous 2023) ^[1]. Sixty-seven per cent of cotton is produced under rainfed conditions and 33% under irrigated conditions. Most of the rainfed area, soils are shallow to medium depth, have low water holding capacity leading to limited growth and yields. Due to this cotton productivity in India is very low (445 kg/ha) as compared to global cotton productivity (775 kg/ha) (Anonymous, 2022) ^[1]. Andhra Pradesh, as the second-largest cotton-producing state in South zone, faces similar challenges in cotton productivity. During Kharif season, the crop is mainly grown as a rain-fed crop in the areas of Kurnool, Palnadu, Ananthapuramu, Prakasam and YSR districts. These districts have constituted 78.89 percent of the total cropped area under cotton crop in the state during the year 2022-23. In the state, area under cotton was 7.04 lakh ha, with production of 15.47 lakh bales, but productivity was 374 kgs/hectare during 2022-23 (Season and Crop Report, A.P, 2022-23). To overcome this challenge HDPS method of cotton cultivation created an option for improving the productivity in rainfed situations. The aim of HDPS is to enhance cotton productivity per unit area rather than per plant basis by targeting amenable cultivars to soil type with appropriate geometry (Prasad *et al.*, 2023) ^[6]. In HDPS technology short-duration, semi-compact cotton types are planted with

population of 74,073 plants per hectare, with a distance of 90 cm between rows and 15 cm between plants in a row with seed rate of 7.125 kg/ha. For maintaining accurate spacing cost-effective manual push seed planter was used with which one hectare can be completed in a single man day. Crop production practices are similar with conventional cotton cultivation except canopy management in HDPS technology. Canopy management was done with PGR i.e. mepiquat chloride 1 ml/lit when top five internal nodal distance is more than 20 cm. This helped maintain optimal plant height and promoted reproductive growth (sympodial branches) (Venugopalan, 2019) [14]. To tracing the advantages of the technology present study conducted in rainfed areas of the project.

2. Methodology

Krishi Vigyan Kendra, Yagantipalle is situated at 15° 32'56" 0" N Latitude, 78° 20' 0" E Longitude at altitude of 1366 m MSL. Total annual actual rainfall varied between 392.90 mm to 794.86 mm during 2023-24 and 2024-2025 and average actual rainfall was 548.97 mm during (June-October) cropping period. The monthly mean maximum and minimum temperatures during the study period ranged from 32.50° C to 39.20°C and 23.20 to 26.60° C, respectively.

A descriptive research design was used to analyze the factors influencing cotton production. Data collection was carried out using a structured interview schedule, with 60 farmers purposively selected based on the HDPS demonstrations conducted from 2023-24 to 2024-25 in 60 locations from three blocks: Nandikotkur, Midthur, and Jupadu bungalow of Nandyal district. The data were analyzed using frequency and percentage to understand the benefits, and challenges of HDPS in enhancing cotton productivity. Each demonstration was laid with 90x15cm spacing and control 120x30 cm with same hybrid (RCH-971 BG-II) under special project on cotton for targeting technology to agro-ecological zones and large-scale demonstrations of best practices to enhance cotton productivity by ICAR-CICR, Nagpur. Technological intervention in the project was increasing of seed rate from 2 packets per acre to 6 packets, and initiating canopy management for restricting closer crop through mepiquat chloride with 1 ml/lit at 45, 65 and 90 DAS on need basis.

The yield and economic performance of the demonstration was collected and the data is interpreted and presented in terms of percentage and quantity. Finally, the Kapas yield, cost of cultivation, net returns with benefit cost ratio were worked out.

An average of cost of cultivation, yield and net returns of different farmers was analyzed by the formula.

Average = $[F_1 + F_2 + F_3 + \dots + F_n] / N$; F_1 = Farmer; N = No. of Farmers.

In the present study, technology index was operationally defined as technical feasibility obtained due to implementation of demonstrations on HDPS Cotton. To estimate the technology gap, extension gap and technology index the following formula were used as suggested by Samui *et al.* (2000) [10], Dayanand and Mehta (2012) [4].

Per cent increase in yield = $\frac{\text{Demonstration yield} - \text{Farmers yield}}{\text{Farmers yield}} \times 100$

Technology Gap = P_i (Potential yield) - D_i (Demonstration yield)

Extension Gap = D_i (Demonstration yield) - F_i (Farmers yield)
Technology index = $[(\text{Potential yield} - \text{Demonstration yield}) / \text{potential yield}] \times 100$.

Multi Lenoir regression analysis was executed to determine the degree to which independent variables influenced the dependent variable (usage of HDPS Packages) among the demonstration farmers of the special project on HDPS Cotton in Nandyal dit.

3. Results and Discussion

The perusal of data (Table-2) indicated that, in demonstration farmers recorded 22.35q/ha yield, in conventional method it was 18.25q/ha. It indicates technology got 23.75 per cent of more yield than conventional method. The results clearly indicate that the higher average yield was obtained in demonstration plots over the farmer's practice due to more plant population per unit area. Though cost of cultivation is more in experiment plot but benefit cost ratio is higher (1: 1.82) than control.

3.1 Comparison with conventional practice:

HDPS cotton exhibited a shorter crop duration of 150 days, compared to the traditional cotton's 180 days, enabling quicker harvesting. This shorter growing season allows farmers to cultivate a second crop such as Bengal gram, safflower 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. In terms of yield, HDPS Cotton achieved 12-14 quintals per acre in light red soils, whereas traditional cotton produced 7-9 quintals per acre under black soils. 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.

Table 1: Difference between demonstration practice (HDPS) and farmer's practice (Conventional) in the study area

S. No	Particulars	Conventional method	HDPS method
1.	Soil type	Red Soils	Red soils
2.	Soil Depth	Light soils	Shallow, Medium soil
3.	Farming situation	Rain fed	Rain fed
4.	Seed rate	6.5 packets	15 packets
5.	Spacing Adopted	120 x 30 cm	90 x 15 cm
6.	Mode of sowing	Manual	Manual Push Planter
7.	No. of plants per ha.	27,778	74,073
8.	Hybrid Used	RCH 971 BG-II	RCH 971 BG-II
9.	Canopy Management	Not require	Two sprayings of Mepiquat Chloride
10.	No. of burst bolls per plant (Randomly selected 25 Plants/ha)	33	16
11.	Seed cotton weight of one fully burst boll (gram)	4.3	4.0
12.	No. of Pickings	3.0	2.0
13.	Crop duration	180	145
14.	Yield of First Picking (q/ha)	19.1	23.1
15.	Yield of Second Picking (q/ha)	5.0	9.9
16.	Yield of Third Picking (q/ha)	2.6	0

3.2 Yield parameters

The perusal of data (Table 2) indicate that HDPS demonstrations cotton yield ranged from 12.4 q/ ha to 32.3 q/ha in demonstration plots and from 9.8 q/ ha to 26.7 q/ ha in farmer's practice in two years of demonstrations recorded from 2023-24 to 2024-25. An average yield of 22.3 q/ ha was obtained under demonstration plots as compared to farmer's practice plots yield 18.25 q/ha 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. The average yield of cotton increased by 23.75 per cent compared to farmer's practice. These findings line with results of Saritha *et al.* (2024)^[11].

3.3 Extension gap

Extension gap of 2.6 and 5.6 q/ha was observed during 2023-24, and 2024-25 respectively (Table-2). On an average extension gap under two years was 4.1 q/ha. This emphasizes the need to educate the farmers through various techniques for the adoption of improved agricultural production technologies to reverse this

trend of wide extension gap.

3.4 Technology gap

The technology gap is the difference between potential yield and yield of demonstration plots which was recorded as 22.6 and 2.7 q/ha during 2023-24, and 2024-25 respectively. On an average technology gap under two year was 12.65q/ha. This may be due rainfall pattern 123 mm to 342 mm respectively 2023-2024. Hence, location specific recommendations are necessary to bridge these gaps. These findings are similar to Singh *et al.* (2011)^[13] and Misra *et al.* (2019)^[5].

3.5 Technology Index

The technology index shows the feasibility of the demonstrated technology at the farmer's field. The technology index varied from 64.5 to 7.71 (Table2). On an average technology index was 36.14 per cent, observed during the two years of programme, which shows the effectiveness of technical interventions. This accelerates the adoption of demonstrated technical interventions to increase the yield productivity of rainfed cotton.

Table 2: Productivity, technology gap, technology index and extension gap in HDPS Cotton

Year	Cotton Yield			% increase in productivity	Technology gap (qt ha ⁻¹)	Extension Gap (qt ha ⁻¹)	Technology index (%)
	Potential yield (qt/ ha)	Demo yield (qt/ha)	Farmer practice yield (qt/ha)				
2023-24	35.0	12.4	9.80	26.53	22.6	2.6	64.5
2024-25	35.0	32.3	26.7	20.97	2.7	5.6	7.71
		22.35	18.25	23.75	12.65	4.1	36.14

3.6 Economic returns: In order to find the economic feasibility of the demonstrated technologies over the control, some economic indicators like cost of cultivation, net returns and B:C ratio was worked out. The economic viability of HDPS Cotton over farmer's practice was calculated depending on prevailing price of inputs. Output costs are represented in the form of B:C ratio (Table3). It was found that the cost of production of cotton under demonstration varied from Rs. 31,700 to 68,250 per ha with an average of Rs. 49,975 as against Rs 31,075 to 72,987 with an average of Rs. 52,031 under control or farmer's practice. The additional cost increased in control or farmer's practice was

mainly due to cost involved in sowing, fertilizers and pest and disease management under conventional method. Demonstration gave higher net return of Rs. 52,450 per ha, and Rs. 1,35,240 per ha during the years 2023-24, and 2024-25 respectively with an average net return of Rs.93,845 per ha which was Rs 58,293 per ha in farmer's practice. The average benefit cost ratio in demonstration plot was 1.82 and 1.12 for farmers practices was observed. The results are in tune with the findings of Raja Madhu Shekar *et al.*, (2025)^[7] Sam *et al.*, (2023)^[9] and Rajib *et al.*, (2022)^[8].

Table 3: Economic returns of the demonstrations:

Year	Yield/ha		Gross cost		Gross income		Net income		B:C ratio		Rainfall
	HDPS	Farmer practice	HDPS	Farmer practice	HDPS	Farmer practice	HDPS	Farmer practice	HDPS	Farmer practice	
2023-24	12.4	9.8	31,700	31,075	84,150	66,300	52,450	35,225	1.65	1.13	- 36%
2024-25	32.3	24.5	68,250	72,987	2,03,490	1,54,350	1,35,240	81,362	1.98	1.11	+ 21%
Mean	22.3	17.1	49,975	52,031	1,43,820	1,10,325	93,845	58,293	1.82	1.12	

3.7 Multi-Lenoir Regression analysis of Socio personal variables with their adoption of HDPS technology in cotton

All the ten independent variables along with the dependent variable i.e. 'adoption of HDPS Packages' were further taken into account for regression analysis. The findings of the analysis are presented in the Table 4. Among the ten independent variables fitted in the multi-Lenoir regression analysis, it was found that Education, Experience and risk bearing ability emerged as the major significant characteristics with the 0.01 level of significance. These three variables may be termed as the good predictors of adoption of HDPS Technologies in cotton among the demonstration farmers.

Age, Landholding, digital literacy and innovativeness emerged as the most significant characteristics with the 0.05 level of significance and beta value (b) of 0.135, 0.139, 0.208 and 0.148 respectively. And other three independent variables (family size, source of information and social participation) were found not significant at 0.05 and 0.01 levels.

The R² value being 0.617, it can be suggested that all the ten independent variables contributed towards to the variation in the adoption of HDPS Technologies among the demonstration farmers. The F value (10.432) was also found to be significant at 0.01 level of probability.

Table 4: Multi-Linear Regression analysis of Socio personal variables with their adoption in HDPS technology in cotton

Sl. No.	Independent variables	Beta	Standard error (S.E)	't' value
1.	Age	0.135	0.758	1.343*
2.	Education	0.421	0.330	5.146**
3.	Family size	-0.007	0.860 (NS)	-0.083
4.	Landholding	0.139	0.381	2.049*
5.	Experience in cotton cultivation	0.314	0.270	4.206**
6.	Source of information	0.068	0.065 (NS)	0.750
7.	Social participation	0.010	0.655 (NS)	0.126
8.	Digital literacy	0.208	0.582	2.186*
9.	Risk bearing ability	0.257	0.154	3.396**
10.	Innovativeness	0.148	0.346	2.013*

**significant at 0.01 level of probability, $R^2= 0.617$ $F= 10.432$

*significant at 0.05 level of probability

4. Challenges faced in HDPS Cotton cultivation:

It was challenging to maintain precise intra-row spacing in HDPS when manual sowing was used, and the HDPS approach required appropriate knowledge of hybrids. Promoting the technology in productive or black soils may increase vegetative growth and improve the plant canopy so that, PGR can be used in accordance with the technology's protocol.

5. Conclusion

It can be concluded that, HDPS is a possible method in reversing the current trend of static yields in rainfed cotton-growing areas with application of HDPS in conjunction with adequate agronomic approaches, plant protection management, and superior genotypes. The findings suggest that HDPS cotton offers significant potential for improving cotton productivity in India, particularly in rainfed regions of Andhra Pradesh.

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