



Economic Analysis of High Density Cotton Farming Systems in Telangana

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study was taken up in three districts (Adilabad, Warangal and Nagarkurnool) from three different zones of Telangana (Northern, Central and Southern). It evaluated the economic benefit of HDPS cotton by comparing it with non HDPS cotton. For this study, multistage sampling was used. HDPS adopters and non-adopters were equally picked from each zone based on the proportionate level of technology adoption. In order to create a sample size of 180 farmers, a total of 90 HDPS adopters and 90 HDPS non-adopters from three agroclimatic zones of Telangana. Cost of

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cultivation of HDPS cotton for marginal, small and large farms was found to be ₹ 96,376.74, ₹ 98,607.71 and ₹ 1,00,355.77 and in non HDPS cotton, ₹ 91,229.89, ₹ 93,211.99 and ₹ 95,346.71 for marginal, small and large farms respectively. The cost of cultivation for pooled HDPS and non HDPS farms was ₹ 98,239.49 and ₹ 93,266.07 per hectare respectively. The cost difference between the HDPS and non HDPS cotton was ₹ 4,973.42 per hectare. Among the selected three districts of three zones of Telangana, cost of cultivation of pooled HDPS cotton farmers was high for Nagarkurnool with ₹ 97,802.37 per hectare followed by Adilabad and Warangal (Urban and Rural) with ₹ 96,320.62 and ₹ 96,121.03 per hectare respectively. The gross returns and net returns were more for Adilabad district with ₹ 1,32,452.47 and ₹ 33,231.24 per hectare followed by Nagarkurnool with ₹ 1,28,254.13 and ₹ 31,982.02 and Warangal with ₹ 1,27,452.45 and ₹ 32,252.21 per hectare, respectively. The farm business income for HDPS cotton farms was found to be ₹ 75,857.40 per hectare which is higher than non HDPS farms *i.e.*, ₹ 61,241.23 per hectare. The family labour income of the HDPS farmer was also found to be more for HDPS cotton *i.e.*, ₹ 45,784.11 per hectare compared to the non HDPS cotton farms *i.e.*, ₹ 31,502.68 per hectare. Because of high farm business income, the family investment income was more for HDPS cotton *i.e.*, ₹ 65,665.92 per hectare as compared to the non HDPS cotton *i.e.*, ₹ 53,225.01 per hectare respectively. The average gross returns of HDPS cotton across the State on selected marginal, small and large farms were ₹ 1,17,750.00, ₹ 1,28,587.50 and ₹ 1,38,125.12 per hectare, respectively. Similarly, the net profits for HDPS cotton over cost C₂ basis on marginal, small and large farms in the state were ₹ 21,373.26, ₹ 29,979.80 and ₹ 37,769.35 per hectare respectively. Average yield obtained in HDPS cotton farms was 20.25 quintal per hectare and for non HDPS cotton farms it was 17.95 quintal per hectare.

Keywords: Cotton; economic impact; high density planting system; cost of cultivation.

1. INTRODUCTION

Cotton is known for its versatility, performance and natural comfort. The most often used elements of the cotton plant are cotton lint and cotton seeds. Cotton lint, its strength and absorbency make it an ideal fabric to make clothes and homewares and industrial products like tarpaulins, tents, hotel sheets, army uniforms and even astronauts' clothing choices when inside a space shuttle. Mainly linters which are short fibres remains on the seed are used to produce the goods such as bandages, swabs, bank notes, cotton buds and x-rays etc. Cotton seed, that makeup around half the weight of the picked cotton, is used as feed for cattles and seeds are crushed to make oil which are of cholesterol free. One tonne of cotton seed yields approximately 200 kg of oil, 500 kg of cotton seed meal and 300 kg of hulls [1]. Globally, cotton seed production can potentially provide protein requirements for hundreds of millions of people and animals.

In particular, genetically modified seeds and fertilizers are used in over 99% of cotton production. Additionally, around 10% of pesticides and 25% of insecticides used globally are used on cotton. The use of chemical fertilizers and pesticides generally has a detrimental effect on the ecosystem, according

to the World Wildlife Fund (WWF). They might cause pollution and harm the water. Considering the fact that cotton is typically biodegradable, cotton goods shouldn't be disposed of in landfills. When biodegradable objects, such as cotton clothing, personal care items, or other throwaway items, are dumped in landfills, they must go through anaerobic biodegradation, which results in the release of the dangerous greenhouse gas methane.

When you consider all of these elements, it becomes clear how cotton production and deterioration can have a negative effect on the ecosystem and contribute to global warming. So, despite being a natural fiber, cotton isn't always sustainable. To ensure that the cotton items you buy have a minimal impact on the environment, it's crucial to read the labels and choose organic cotton while making your purchases. The Soil Association also discovered that growing organic cotton reduces water pollution by 26% and greenhouse gas emissions by 46%. Neither harsh pesticides nor genetically engineered seeds are used in the production of organic cotton.

Therefore, organic cotton more eco-friendly than regular cotton. It is, specifically, greener. It makes use of nature and does not require a lot

of water or inorganic methods, such as artificial pesticides and fertilizers.

Globally, cotton was sown on 32.94 million hectares in the 2021-22 growing season, producing 120.2 million bales with a productivity of 778 kg per hectare. Cotton production in India in 2021-22 was 362.18 lakh bales farmed on 120.69 lakh hectares with a yield of 510 kg per hectare (Cotton Corporation of India, 2022).

India produced 362.18 lakh bales of cotton in 2021–2022, yielding 510 kg per hectare on 120.69 lakh hectares (Cotton Corporation of India, 2022). Maharashtra ranks first place in acreage (42.86 lakh acres) and Gujarat ranks first place in production (90.00 lakh bales). Telangana is the third-largest cotton producer and has the second-largest cotton acreage in India. It is expected that the production will be around 51 lakh bales from a land area of 24.72 lakh hectares during 2020-2021 (<https://www.agri.telangana.gov.in>). Adilabad had the best output of 26.09 quintals per hectare and produced 6.65 lakh bales from an area of 1.40 lakh hectares. Nalgonda had the largest production and area of 7.16 lakh bales and 2.74 lakh hectares respectively with productivity of 14.38 quintals per hectare.

But India's seed cotton production per unit area is still significantly lower than that of several other cotton-growing countries throughout the world. Two of the most prominent factors leading to the country's low cotton crop productivity are a lack of plant population and the use of low-potential cultivars [2]. Several researches are conducted, including maintaining a sufficient plant density, employing the right number of fertilizers, applying growth regulators and so on and released some varieties which are suitable for high density planting system.

The High Density Planting System (HDPS) is a method where planting is done very closely per unit area. It is one of the new systems of cultivation of cotton, popularly known as 'Ultra Narrow Row' cotton developed in India by the Central Institute of Cotton Research, Nagpur in 2010. The system is now being conceived as an alternate production system having a potential for improving productivity and profitability, increasing efficiency, reducing input costs and minimizing risks associated with India's cotton production system. A high density planting system (HDPS) leading to more rapid canopy closure and decreased soil water

evaporation is becoming popular to address water scarcity challenges.

In HDPS, the optimum level of plant population mainly depends upon not only spacing but also on the plant type. Because, present day cotton genotypes have a long duration of 180 to 200 days they are late maturing, tall growing and spreading types leading to bushy appearance, posing problems in taking up plant protection measures, machine picking, inefficient in trapping of solar energy, physiological efficiency and harvest index [3]. Because of longer duration, these varieties require a greater number of pickings as a result leading to manifold increase in cost of cotton cultivation especially manual picking and the margin of profit is low and fluctuating in an erratic manner. These problems are expected to be reduced by using the genotype suitable for HDPS.

To minimize the risk, recently in Telangana, Professor Jayashankar Telangana State Agricultural University, Rajendranagar developed to varieties, ADB-39 and NCS-2778 with a technology *i.e.*, High Density Planting System (HDPS) with the unique spacing of 60 x 20 cm and 80 x 20 cm, in two cotton varieties. One is ADB-39 with the spacing of 60 x 20 cm and another Bt variety NCS-2778 with 80 x 20 cm. HDPS is more relevantly developed by the University that reduces the spacing, increases the number of plants per ha (nearly 1 lakh plants per ha), so that the farmers will get the higher yields. It reduces the cost of cultivation and improve effective surveillance against pests and disease. The present research study on "Economic impact of High Density Planting System in cotton – A case study in Telangana state" was focused to know about economic impact on the HDPS cotton adopted farmers by comparing with non-HDPS cotton adopted farmers.

2. MATERIALS AND METHODS

2.1 Sample Procedure

The present study was conducted in three districts (Adilabad, Warangal and Nagarkurnool) in three different zones of Telangana. Based on the proportion of adoption, from each zone one district was selected. From each district two mandals and from each mandala two villages are selected purposively. From each zone of Telangana 60 samples were selected (Thirty adopter farmers of HDPS Cotton and Thirty non

adopter farmers of HDPS Cotton). A total sample of 180 cotton farmers were selected for the present study. HDPS farmers are selected based on the HDPS farmers list provided by the KVKs and DAATTCs of PJTSAU in the respective districts. Farmer cultivating cotton with same land holdings to that of adopter farmer was selected

as the non-adopter farmer. The data was obtained by a personal contact approach using a scheduled interview schedule and the data was coded, categorised, tabulated, and analysed in light of the objectives and to make the findings practical for making relevant conclusions.

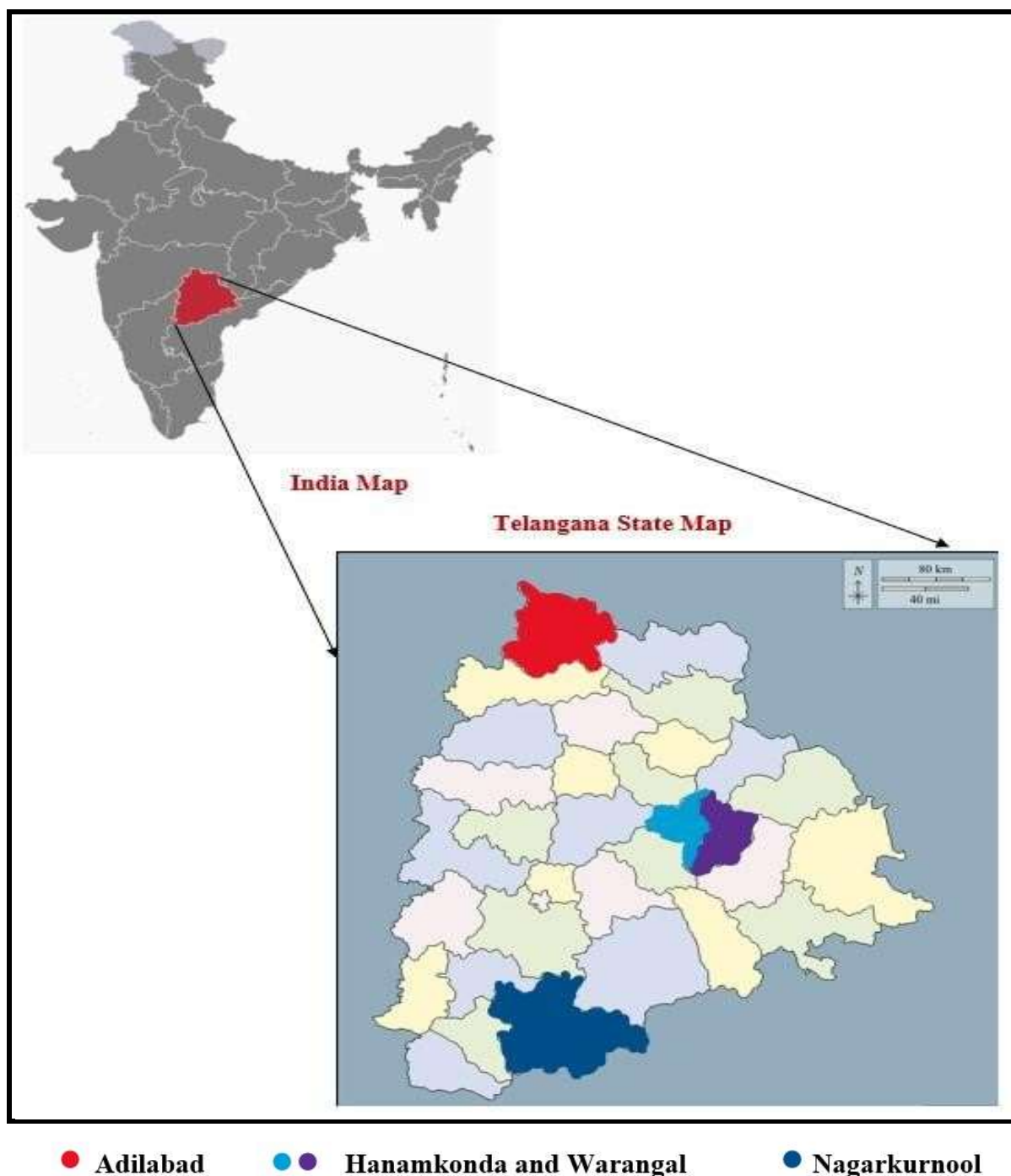


Fig. 1. Pictographical representation of study area

2.2 Cost Concepts

Cost A₁: It contains all actual cash and kind expenditures spent by the farmer in the course of cultivation like Value of human labour, Value of bullock labour (hired and owned), Value of machine power (hired and owned), Value of seeds, Value of fertilizers, Value of farm yard manure, Value of plant protection chemicals, Value of depreciation for implements and farm buildings, Value of land revenue, cess and others taxes, Irrigation charges, Miscellaneous expenses (like electricity charges etc.), Interest on working capital.

Cost A₂: Cost A₁ + Rent paid for leased in land

Cost B₁: Cost A₁ or A₂ + Interest on owned fixed capital assets

Cost B₂: Cost A₁ + Rental value of owned land + Rent paid for leased-in land

Cost C₁: Cost B₁ + Imputed value of family labour

Cost C₂: Cost B₂ + Imputed value of family labour

2.3 Farm Income Measures

- 1) **Gross Returns:** The value of the main product plus the value of the by-product.
- 2) **Net Returns:** Gross income – Total cost of cultivation

3) **Farm Business Income:** Farm business income = Gross income – Cost A₁

4) **Family Labour Income:** Family labour income = Gross income – Cost B₂ (Cost A₁ + Rental value of owned land + Rent paid for leased in land) from gross returns.

5) **Farm Investment Income:** Farm investment income = Farm business income – The imputed value of family labour.

6) **Return Per Rupee Spent:** Return per rupee spent = Gross return ÷ Total cost (or) Cost C₂

3. RESULTS AND DISCUSSIONS

3.1 Cost of Cultivation of HDPS and Non HDPS Cotton

The cost of cultivation of cotton under HDPS and non HDPS were calculated by taking the percentage of each item, the contribution of this item to the overall cost of cultivation, the crop's cost structure was examined during *Kharif* season of 2021 in Telangana state. Additionally, the production cost per hectare was also calculated. To compare the cost differences, the cost of cultivation for the two categories, HDPS and non HDPS methods of cotton crop was calculated separately.

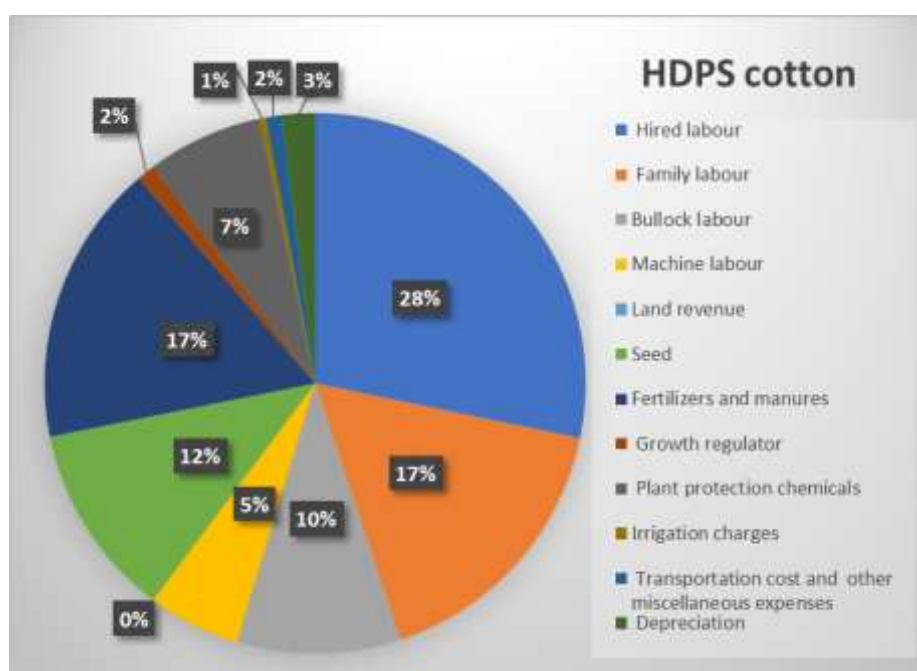


Fig. 2. Composition of cost of cultivation of pooled HDPS cotton farms

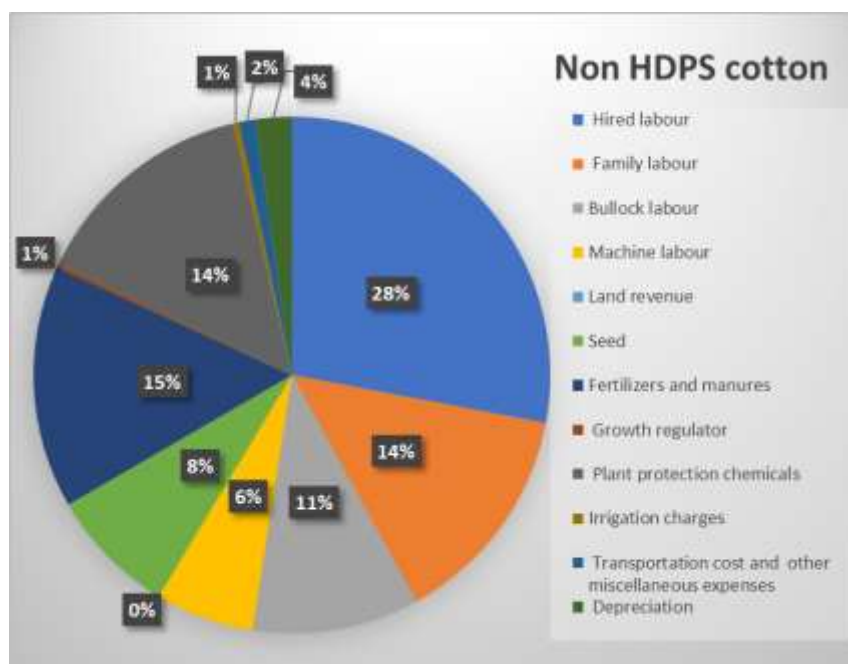


Fig. 3. Composition of cost of cultivation of pooled non HDPS cotton farms

From Table 1 and Table 2 it could be observed that the pooled per hectare cost of cultivation of HDPS and non HDPS cotton was in order of ₹ 98,239.49 and ₹ 93,266.07 per hectare, respectively. The cost of cultivation of HDPS cotton was higher by ₹ 4,973.42. The variable cost of HDPS cotton cultivation was found to be slightly higher *i.e.*, 63.37 per cent, when compared to the variable cost of non HDPS, which was 62.28 per cent. Among all the components of variable cost, human labour occupied the highest share in both, HDPS and non HDPS cotton cultivation *i.e.*, 17.65 per cent and 17.15 per cent respectively. The results were in line with the results of Reddy et al. [4].

In the HDPS cotton method, due to more number of plants per hectare, the requirement of seed and fertilizer is usually more compared to normal cotton cultivation obviously the cost of seed and fertilizers were found to be more for HDPS cotton *i.e.*, at ₹ 7,125.56 (7.25%) and ₹ 10,356.16 (10.54%) as compared to non HDPS cotton at ₹ 4,580.28 (4.91%) and ₹ 8,693.12 (9.32%) respectively. Most of the farmers were using human labour for frequent weeding instead of bullocks and machinery, as a result, the cost of bullock labour and machinery labour was low in HDPS cotton at ₹ 6,029.43 (6.14%) and ₹ 3,392.33 (3.45%) as compared to non HDPS cotton at ₹ 5,980.96 (6.41%) and 3,532.83 (3.79%), respectively. Most of the adopter farmers were using growth regulators for early

maturity of cotton plant, as the result, the cost of growth regulators was more in HDPS cotton at ₹ 666.45 (0.68%) as compared to non HDPS cotton at ₹ 147.61 (0.16 %) respectively. As the varieties of the HDPS cotton were more pest resistant and short duration in nature, the attack of pink boll worm and other pests was expected to be low compared to the non HDPS cotton.

As a result, low amount of plant protection chemicals were needed for HDPS cotton compared to non HDPS cotton which cost at ₹ 4,242.66 (4.32%) and ₹ 8,134.08 (8.72%) for HDPS and non HDPS cotton, respectively. The proportion of fixed costs was marginally higher in total cost of HDPS cotton cultivation at ₹ 35,987.23 per hectare as compared to non HDPS cotton cultivation *i.e* at ₹ 35,179.54 per hectare. Almost similar proportional differences were observed between HDPS and non HDPS marginal, small and large category farmers also.

3.2 Cost Concepts

Costs A₁, A₂, B₁, B₂, C₁, C₂ per hectare were calculated for this purpose and were shown in Table 3 and in Fig. 4. Among the different costs, cost C₂ includes both fixed and variable costs. It provides a basis for comparison between various size of operational holdings. As a result, cost C₂ has been considered as the basis for calculating cost of cultivation.

The cost A_1 ranged from ₹ 51,840.83 on marginal to ₹ 54,607.98 on large farms for HDPS cotton and ₹ 50,856.31 on marginal to ₹ 51,901.52 on large farmers for non HDPS cotton. On an average, cost A_1 on pooled farm of HDPS cotton (₹ 53,274.01) was more compared to non HDPS (₹ 51,379.94). In HDPS cotton production, the cost A_1 for marginal farmers was low because they have limited resources at their disposal to invest on the inputs for cultivation.

Cost B_1 ranged from ₹ 54,983.72 on marginal farms to ₹ 58,046.79 on large farms for HDPS cotton and ₹ 53,967.43 on marginal farms to ₹ 55,192.32 on large farms for non HDPS cotton and for pooled farm of HDPS cotton it was more (₹ 56,354.19 per hectare) than non HDPS (₹ 54,578.08 per hectare).

Cost B_2 also showed a positive relationship with farm size. It is observed to be ₹ 85,576.38 on marginal farms, ₹ 88,393.19 for small farms and ₹ 90,796.13 for large farms of HDPS cotton and ₹ 84,027.21 for marginal farms, ₹ 85,411.05 for small farms, ₹ 86,549.66 for large farms of non HDPS cotton. On an overall, cost B_2 for HDPS cotton (₹ 88,048.01 per hectare) was more compared to non HDPS cotton (₹ 85,249.85 per hectare).

Cost C_1 was estimated by adding B_1 to the imputed value of family labour. Cost C_1 ranged from ₹ 65,784.02 per hectare on marginal to ₹

67,606.41 per hectare on large farms for HDPS cotton and ₹ 61,168.78 per hectare on marginal farm to ₹ 64,238.57 per hectare on large farm for non HDPS cotton. Overall, cost C_1 of HDPS cotton (₹ 66,545.67 per hectare) was more compared to the non HDPS cotton (₹ 62,594.32 per hectare).

From the Table 4 it could be observed that imputed value of family labour was more for marginal farmers *i.e.*, ₹ 10,800.31 per hectare, but the cost C_1 was more for large farms *i.e.*, ₹ 67,606.41 per hectare due to more intensive use of hired labour, fertilizers, manure, seeds and plant protection chemicals.

Same as the cost C_1 , Cost C_2 was calculated by adding B_2 with imputed value of family labour. The cost C_2 ranged from ₹ 96,376.74 per hectare on marginal to ₹ 1,00,355.77 per hectare on large farms of HDPS and ₹ 91,229.89 per hectare of marginal farm to ₹ 95,346.71 per hectare of large farm of non HDPS cotton. Overall, cost C_2 of HDPS cotton was ₹ 98,239.49 per hectare which was more compared to non HDPS cotton *i.e.*, ₹ 93,266.07 per hectare. The findings of this study have in close conformity with the findings reported by Reddy et al. [5].

It is clearly evident from the above discussion that various cost concepts indicated a direct and positive relationship with the farm size.



Fig. 4. Cost of cultivation of pooled HDPS cotton adopter farms and non adopter farms as per cost concepts

Table 1. Variable costs in HDPS and non HDPS cotton cultivation (₹/ha)

| Particulars | HDPS adopters | | | | HDPS non adopters | | | |
|------------------------------------|----------------------|----------------------|----------------------|---------------------|----------------------|----------------------|---------------------|---------------------|
| | Marginal farms | Small farms | Large farms | Pooled farms | Marginal farms | Small farms | Large farms | Pooled farms |
| Variable costs | | | | | | | | |
| a) Labour cost | | | | | | | | |
| 1. Hired labours | 16050.24 (16.65) | 17301.35 (17.55) | 18651.75 (18.59) | 17334.67 (17.65) | 15150.91 (16.61) | 15780.88 (16.93) | 17058.53 (17.89) | 15996.92 (17.15) |
| 2. Family labours | 10800.31 (11.20) | 10214.23 (10.36) | 9559.62 (9.53) | 10191.48 (10.37) | 7201.35 (7.89) | 7800.55 (8.37) | 9046.25 (9.49) | 8016.22 (8.60) |
| 3. Bullock labours | 6085.75 (6.31) | 6052.03 (6.14) | 5950.12 (5.93) | 6029.43 (6.14) | 6180.55 (6.77) | 6080.82 (6.52) | 5681.23 (5.96) | 5980.96 (6.41) |
| 4. Machinery labours | 3350.57 (3.47) | 3450.82 (3.50) | 3375.14 (3.36) | 3392.33 (3.45) | 3376.31 (3.70) | 3639.19 (3.90) | 3580.55 (3.76) | 3532.83 (3.79) |
| b) Material cost | | | | | | | | |
| 1. Seed | 7200.22 (7.47) | 7150.32 (7.25) | 7025.45 (7.00) | 7125.56 (7.25) | 4688.54 (5.14) | 4551.25 (4.88) | 4500.35 (4.72) | 4580.28 (4.91) |
| 2. Fertilizer and manure | 10376.11 (10.76) | 10550.45 (10.70) | 10140.25 (10.10) | 10356.16 (10.54) | 8801.75 (9.56) | 8950.75 (9.60) | 8325.62 (8.73) | 8693.12 (9.32) |
| 3. Growth regulators | 656.82 (0.68) | 678.45 (0.69) | 663.56 (0.66) | 666.45 (0.68) | 133.23 (0.15) | 160.34 (0.17) | 148.68 (0.16) | 147.61 (0.16) |
| 4. Plant protection chemicals | 4375.32 (4.54) | 4100.23 (4.16) | 4250.45 (4.24) | 4242.66 (4.32) | 8300.75 (9.10) | 8150.53 (8.74) | 7950.42 (8.34) | 8134.08 (8.72) |
| 5. Irrigation charges | 208.32 (0.21) | 223.22 (0.23) | 247.77 (0.25) | 226.64 (0.23) | 198.24 (0.22) | 210.57 (0.23) | 233.07 (0.24) | 214.10 (0.23) |
| 6. Miscellaneous cost | 611.25 (0.63) | 583.25 (0.59) | 550.27 (0.55) | 581.73 (0.59) | 625.32 (0.69) | 583.25 (0.63) | 525.60 (0.55) | 578.25 (0.62) |
| Total working capital | 59714.91 (61.95) | 60304.35 (61.15) | 60414.38 (60.20) | 60147.11 (61.22) | 54656.95 (59.91) | 55908.13 (59.48) | 57050.31 (59.83) | 55874.37 (59.91) |
| 7. Interest on working capital @7% | 2,090.02 (2.16) | 2110.65 (2.14) | 2114.50 (2.11) | 2105.14 (2.14) | 2350.62 (2.58) | 2,188.12 (2.35) | 2097.61 (2.20) | 2212.16 (2.37) |
| Total variable cost (I) | 61,804.93 (64.13) | 62,415.00 (63.30) | 62,528.88 (62.31) | 62252.25 (63.37) | 57,007.57 (62.49) | 58,096.25 (62.33) | 59147.84 (62.03) | 58086.53 (62.28) |

*Figures in parenthesis indicates percentage to the total

Table 2. Fixed costs in HDPS and non HDPS cotton cultivation (₹/ha)

| Particulars | HDPS adopters | | | | HDPS adopters | | | |
|--|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| | Marginal farms | Small farms | Large farms | Pooled farms | Marginal farms | Small farms | Large farms | Pooled farms |
| 1. Rent value of own land | 26165.31 (27.14) | 27,005.53 (27.39) | 27,852.77 (27.75) | 26993.11 (27.48) | 26176.15 (28.69) | 26,394.58 (28.32) | 27049.92 (28.37) | 26540.41 (28.46) |
| 2. Rent paid for leased in land | 4427.35 (4.59) | 4732.69 (4.80) | 4896.57 (4.88) | 4700.71 (4.78) | 3883.63 (4.26) | 4202.39 (4.51) | 4307.42 (4.52) | 4131.36 (4.43) |
| 3. Land revenue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4. Depreciation on implements and farm buildings | 836.25 (0.86) | 1164.21 (1.18) | 1638.75 (1.63) | 1213.23 (1.23) | 1051.42 (1.15) | 1326.43 (1.42) | 1550.73 (1.63) | 1309.63 (1.40) |
| 5. Interest on fixed capital@ 10% | 3142.89 (3.26) | 3,290.21 (3.34) | 3438.81 (3.43) | 3080.18 (3.14) | 3111.12 (3.41) | 3192.34 (3.42) | 3290.80 (3.45) | 3198.14 (3.43) |
| Total fixed costs (II) | 34,571.81 (35.87) | 36,192.64 (36.70) | 37,826.89 (37.69) | 35,987.23 (36.63) | 34,222.32 (37.51) | 35,115.74 (37.67) | 36,198.87 (37.97) | 35,179.54 (37.72) |
| Total cost (I+II) | 96,376.74 (100) | 98,607.71 (100) | 1,00,355.77 (100) | 98,239.49 (100) | 91,229.89 (100) | 93,211.99 (100) | 95,346.71 (100) | 93,266.07 (100) |

*Figures in parenthesis indicates percentage to the total

Table 3. Cost concepts estimated for HDPS cotton adopters and non adopters (₹/ha)

| Cost concepts | HDPS of cotton | | | | Non HDPS of cotton | | | |
|---------------------|----------------|-------------|-------------|--------------|--------------------|-------------|-------------|--------------|
| | Marginal farms | Small farms | Large farms | Pooled farms | Marginal farms | Small farms | Large farms | Pooled farms |
| Cost A ₁ | 51,840.83 | 53,364.76 | 54,607.98 | 53,274.01 | 50,856.31 | 51,621.74 | 51,901.52 | 51,379.94 |
| Cost A ₂ | 56,268.18 | 58,097.45 | 59,504.53 | 57,974.72 | 54,739.94 | 55,824.13 | 56,208.94 | 55,511.31 |
| Cost B ₁ | 54,983.72 | 56,654.97 | 58,046.79 | 56,354.19 | 53,967.43 | 54,814.08 | 55,192.32 | 54,578.08 |
| Cost B ₂ | 85,576.38 | 88,393.19 | 90,796.13 | 88,048.01 | 84,027.21 | 85,411.05 | 86,549.66 | 85,249.85 |
| Cost C ₁ | 65,784.02 | 66,869.12 | 67,606.41 | 66,545.67 | 61,168.78 | 62,614.63 | 64,238.57 | 62,594.32 |
| Cost C ₂ | 96,376.74 | 98,607.71 | 1,00,355.77 | 98,239.49 | 91,229.89 | 93,211.99 | 95,346.71 | 93,266.07 |
| Gross returns | 1,17,750.00 | 1,28,587.50 | 1,38,125.12 | 1,29,131.41 | 1,01,562.51 | 1,13,697.50 | 1,18,875.02 | 1,12,621.17 |

Table 4. Yield and income from HDPS and non HDPS cotton cultivation

| S. No. | Yield and Income | HDPS of cotton | | | | Non HDPS of cotton | | | |
|--------|-------------------------------|----------------|-------------|-------------|--------------|--------------------|-------------|-------------|--------------|
| | | Marginal farms | Small farms | Large farms | Pooled farms | Marginal farms | Small farms | Large farms | Pooled farms |
| 1. | Cost of cultivation(₹/ha) | 96,376.74 | 98,607.71 | 1,00,355.77 | 98,239.49 | 91,229.89 | 93,211.99 | 95,346.71 | 93,266.07 |
| 2. | Yield (q/ha) | 18.75 | 20.25 | 21.25 | 20.25 | 16.25 | 18.25 | 18.75 | 17.95 |
| 3. | Price (₹/q) | 6,280.00 | 6,350.00 | 6,500.10 | 6,376.86 | 6,250.00 | 6,230.00 | 6,340.00 | 6,274.16 |
| 4. | Gross returns(₹/ha) | 1,17,750.00 | 1,28,587.50 | 1,38,125.12 | 1,29,131.41 | 1,01,562.51 | 1,13,697.50 | 1,18,875.02 | 1,12,621.17 |
| 5. | Farm business income (₹/ha) | 65,909.18 | 75,222.75 | 83,517.14 | 75,857.40 | 50,706.21 | 62,075.76 | 66,973.51 | 61,241.23 |
| 6. | Family labour income(₹/ha) | 36,600.98 | 44,927.02 | 52,225.56 | 45,784.11 | 21,418.93 | 32,488.84 | 36,632.78 | 31,502.68 |
| 7. | Farm investment income (₹/ha) | 55,108.87 | 65,008.72 | 73,957.52 | 65,665.92 | 43,504.86 | 54,275.21 | 57,927.26 | 53,225.01 |
| 8. | Net returns (₹/ha) | 21,373.26 | 29,979.80 | 37,769.35 | 30,891.92 | 10,262.62 | 20,485.51 | 23,528.31 | 19,355.10 |
| 9. | Returns per rupee spent | 1.22 | 1.30 | 1.37 | 1.31 | 1.11 | 1.22 | 1.24 | 1.20 |

3.3 Farm Income Measures of HDPS and Non HDPS Cotton

The outcomes of various farm income measures were shown in Table 4 and illustrated in the Fig. 5.

3.3.1 Farm business income

As the farm size increases the farm business income also increased. Farm business income for HDPS cotton was more on large farms (₹ 83,517.14 per hectare) followed by small (₹ 75,222.75 per hectare) and marginal farm (₹ 65,909.18 per hectare) and in case of non HDPS cotton ₹ 66,973.51 for large farms followed by small farms (₹ 62,075.76) and marginal farms (₹ 50,706.21 per hectare). Overall, farm business income for HDPS and Non HDPS cotton was ₹ 75,857.40 and ₹ 61,241.23 per hectare respectively. Higher farm business income was obtained by large farms in both HDPS and Non HDPS due to their productivity and high net returns compared to small and marginal farms. Further, in all sizes of farms, HDPS farmers income was found to be higher than non HDPS farmers.

3.3.2 Family labour income

The farmer family returns were evaluated by the family labour income. It was obtained by subtracting cost B₂ from gross income. The family labour income increases with farm size

usually due to the economies of scale. Family labour income obtained for HDPS cotton was more for large farms (₹ 52,225.56 per hectare) compared to small (₹ 44,927.02 per hectare) and marginal farms (₹ 36,600.98 per hectare) whereas ₹ 21,418.93 for marginal farms, ₹ 32,488.84 for small farms and ₹ 36,632.78 large farms of non HDPS cotton. Overall, family labour income for HDPS and non HDPS cotton was ₹ 45,784.11 and ₹ 31,502.68 per hectare. It shows clear evidence of superiority of HDPS over non HDPS in terms of returns for the family labour involvement in cotton farming.

3.3.3 Family investment income

It was obtained by subtracting the imputed value of family labour from the farm business income. As the farm size increases, family investment income will also increase. Family investment income obtained was more for large farms (₹ 73,957.52 per hectare) followed by small (₹ 65,008.72 per hectare) and marginal farm (₹ 55,108.87 per hectare) whereas ₹ 57,927.26 per hectare for large farms followed by small (₹ 54,275.21 per hectare) and marginal farm (₹ 43,504.86 per hectare) of non HDPS cotton respectively. Overall, family investment income for HDPS and Non HDPS cotton was ₹ 65,665.92 and ₹ 53,225.01 per hectare, respectively. Here also superiority of HDPS over non HDPS is clearly seen in terms of the performance of the capital invested in farm.

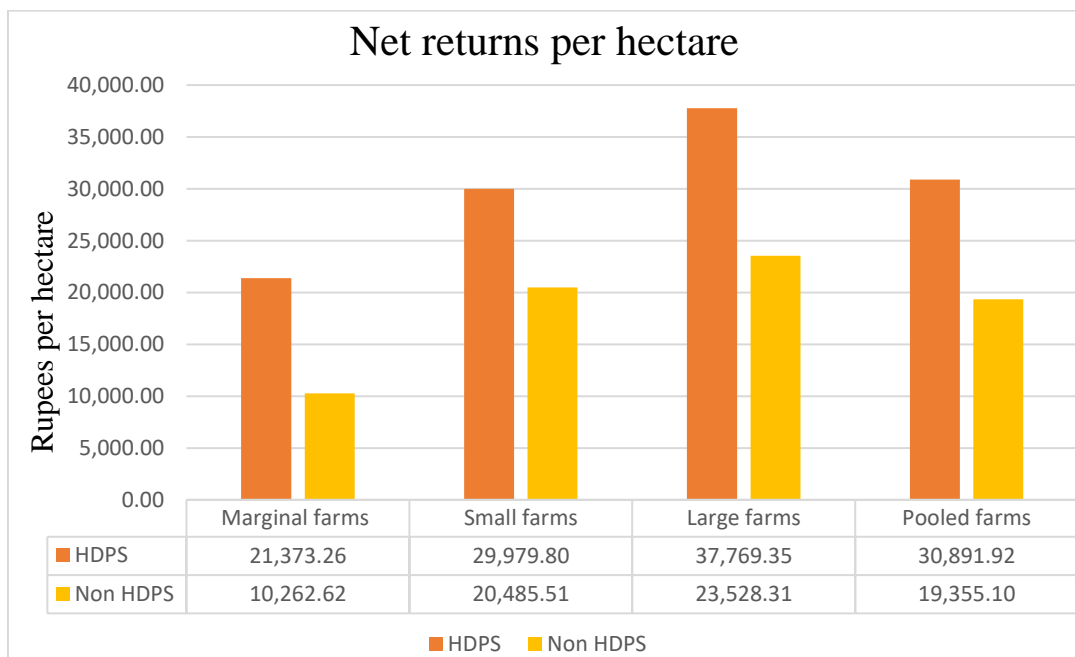


Fig. 5. Farm size wise net returns of HDPS and Non HDPS cotton growers

3.3.4 Net returns

Large farms of HDPS cotton realized more net returns of ₹ 37,769.35 per hectare followed by small farms ₹ 29,979.80 per hectare and marginal farms ₹ 21,373.26 per hectare whereas ₹ 23,528.31 for large farms followed by small (₹ 20,485.51) and marginal (₹ 10,262.62 per hectare) for non HDPS cotton respectively. On an average, the net returns for the HDPS and non HDPS cotton ranged between ₹ 30,891.92 and ₹ 19,355.10 per hectare respectively for different farm sizes.

3.3.5 Return per rupee spent

Return per rupee spent was calculated in order to assess the level of production for every rupee spent on inputs. It is obtained by dividing gross returns with Cost C₂ (total cost of cultivation) and presented in Table 4.

Return per rupee spent for HDPS adopters was more, 1.22 on marginal farms, 1.30 on small farms, 1.37 on large farms and 1.31 for pooled farms whereas for non HDPS adopters, it was 1.11 on marginal farm, 1.22 on small farm, 1.24 on large farm and 1.20 on pooled farm. It shows that HDPS cotton cultivation was profitable across all farm sizes. The results are in accordance with Reddy et al. [5].

From the above discussion of farm income measures for HDPS cotton and non HDPS cotton, it can be concluded that gross returns for HDPS farmers *i.e.*, ₹ 1,29,131.41 per hectare was more compared to non HDPS *i.e.*, ₹ 1,12,621.17 per hectare. Farm business income for HDPS cotton was more (₹ 75,857.40 per hectare) compared to the non HDPS (₹ 61,241.23 per hectare). Due to high yields in the HDPS cotton, the family labour income increases with farm size. Family labour income obtained for HDPS cotton was more (₹ 45,784.11 per hectare) compared to the non-HDPS (₹ 31,502.68 per hectare). Because of high farm business income in HDPS cotton, the family investment income was more for HDPS cotton *i.e.*, ₹ 65,665.92 per hectare as compared to the non HDPS cotton *i.e.*, ₹ 53,225.01 per hectare, respectively. On an average, returns per rupee spent in HDPS cotton was more (1.31) compared to non HDPS cotton (1.20). The results are in the line with the results of Venugopalan et al. [6].

As per the results, the HDPS adopter farmers selected from three districts of three zones of

Telangana were benefited more (on an average ₹ 16,530.23 per hectare in gross returns and ₹ 11,231.15 per hectare in net returns) as compared to non adopters of HDPS cotton [7-10].

4. CONCLUSIONS

- The total cost of cultivation has shown a positive relationship with farm size due to increase in input usage on large farms. In all over cost of cultivation labour costs account for the largest share of the total expenditures followed by costs on seed and fertilizers. Usage of plant protection chemicals was low in HDPS cotton when compared to non HDPS cotton.
- HDPS cotton cultivation has recorded higher gross and net returns. The gross and net returns for HDPS cotton increase with the increase in farm size; they were higher on large farms than on small and marginal farms.
- Net profits were more in HDPS cotton than in non HDPS cotton as high gross returns in HDPS cotton were recorded when compared to non HDPS cotton.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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