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Economic viability of crop residue management technologies in wheat production: A comparative analysis of conventional, happy seeder and super seeder systems in Northern India

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Abstract

Economic efficiency can vary from one region to another and depend upon the specific crop being grown. Economic efficiency of different CRM technologies was found out with the collaboration between agricultural experts, policy makers, private firms and farmers. Punjab had higher average cost in wheat cultivation through conventional practices and super seeder compare to Haryana and Delhi because of very high application of fertilizer, pesticides, preparatory tillage and irrigation in Punjab. Delhi had higher average cost through happy seeder compare to Punjab and Haryana. In Delhi average cost was higher in case of conventional method than Haryana not because of higher application of fertilizer and pesticides but because of very high rental value of land and high wage rate of labor compare to Punjab and Haryana. Through happy seeder techniques higher return found in Punjab compare to Haryana and lowest return found in Delhi in rupees per hectare. In case of super seeder same trend was found as happy seeder. For conventional practices the return was higher in Haryana and negative for Delhi.

Keywords: Wheat, crop residue management, happy seeder, super seeder, cost of cultivation, profitability, technology adoption

Introduction

Crop residue burning in India has been a long standing agricultural practice, primarily driven by the need for rapid land clearance and preparation for the subsequent cropping season. However, this practice has garnered increasing attention due to its detrimental environmental consequences, particularly air pollution, and its adverse impact on soil health. Every year, millions of tones of agricultural residues are produced, with cereal crops such as rice and wheat accounting for the majority of crop residues. India generates on an average 500 million tons of crop residue per year and majority of this crop residue is in fact used as fodder, fuel for other domestic and industrial purposes. However, there is still a surplus of 140 Mt out of which 92 Mt is burned each year (MNRE, 2019) ^[1]. To mitigate these issues, various crop residue burning technologies have been developed and adopted in India. Traditionally, Indian farmers have practiced the burning of crop residues, especially after the rice and wheat harvest seasons. While this approach provides quick land clearance and minimal surface residue, it has detrimental effects on air quality, releasing harmful pollutants into the atmosphere.

The happy seeder is an innovative technology that aims to address the challenges posed by crop residue burning. This machine allows farmers to plant seeds directly into fields with crop residues without the need for prior burning. The happy seeder works by cutting and mulching the standing crop residue while simultaneously sowing the next crop. This technology not only reduces the environmental impact of burning but also enhances soil health by returning organic matter to the soil and improving moisture retention. The adoption of Happy Seeder technology represents a significant shift towards sustainable and eco-friendly farming practices. Similar to the happy seeder, the super seeder is another crop residue management technology designed to minimize the need for burning. It operates by directly sowing seeds into fields with crop residues, thus reducing

the necessity for residue clearance through burning or tilling. The super seeder can be a valuable tool for farmers looking to adopt conservation agriculture practices while simultaneously conserving soil health and minimizing environmental pollution. In recent years, the Indian government, recognizing the urgent need to tackle the issue of crop residue burning, has initiated various policies and subsidies to encourage the adoption of these advanced technologies. These measures aim to promote sustainable farming practices, reduce air pollution, and enhance soil fertility, ultimately contributing to the well-being of both farmers and the environment.

Methodology

An ex-post facto research design was adopted for the present study. Data were collected personally by the researcher by visiting the study area and interviewing the respondents. Proper precautions were taken to ensure unbiased response of the respondents by providing them necessary instructions after explaining the objectives of the study. In addition, focus group discussions were also held with the farmers for in depth probing and understanding of various aspects under study. The study was conducted in Sangrur district of Punjab and Kaithal district of Haryana due to highest incidence of crop residue burning (CREAMS, IARI, 2021) [2]. Delhi also was the part of study because of high level of pollutions and not based the number of burning events. One block from each district selected randomly and one villages from each block also selected randomly that was namely Kheri, Rasina and Alipur respectively. From each village 40 farmers and 3 key respondents selected through simple random sampling. A total of 129 farmers selected for this study. Different official documents, reports and other literature published by the organization and other relevant institutions like KVKs, Farm Testing Centre were referred for the collection of data. The task of data collection was carried out in 2022. Economic feasibility of CRM machinery structured interview schedule was developed and data were collected to 129 respondents.

Results

Cost of wheat cultivation under Conventional Technique (CT), Happy Seeder (HS) and super Seeder Technique (SS) for wheat crop in Kaithal district of Haryana is presented in Table 1.1. Per hectare total cost of cultivation in conventional technique of wheat (Rs. 112526.99/ha) was estimated to be higher as compared to happy seeder (Rs 101212.09) and super seeder technique (Rs. 100829.51). The share of variable cost and fixed cost in total cost of conventional method of wheat were 34.28 percent (Rs.38575.26 /ha) and 65.71 percent (Rs.73951.73), respectively. In case of happy seeder method of wheat the share of variable cost and fixed cost were found to be 28.15 percent (Rs. 28501.3 /ha) and 78.83 percent (Rs. 72710.79 /ha) respectively. Similarly in case of Super seeder method of wheat the share of variable cost and fixed cost were found to be 28.43 percent (Rs. 28671.34 /ha) and 71.56 percent (Rs.72158.17/ha) respectively. In case of Conventional Practices (CP), the highest share of variable cost was on total fertilizer investment 4.9 percentage followed preparatory tillage 3.7 percent, harvesting 3.32 percent, irrigation 2.86 percent and while in fixed cost, maximum cost was incurred on rental value of land 65.71 percent (Rs. 73951.73 /ha) followed by risk factor and management charges which were 3.29 percent (Rs. 3705.87 /ha) of the total cost. In case of happy seeder method, maximum variable cost incurred was on total fertilizer investment 5.28 percent followed by harvesting 3.06 percent, sowing 2.84 percent and irrigation 2.58 percent of variable cost. Whereas, in fixed cost, highest share were incurred on rental value of land 64.22 percent (Rs 65000./ha) followed by risk factor and management charges 3.12 percent each (Rs. 3166.79/ha). Similarly in case super seeder method of wheat maximum variable cost was incurred on total fertilizer investment 5.5 percent followed by harvesting 3.130 and sowing 3.08 percent of total variable cost. Whereas, in case of fixed cost, highest share was incurred on rental value of land 64.46 percent (Rs.65000/ha) followed by risk factor and management charges which were 2.87 percent (Rs. 2674.39/ha) each of total cost of wheat cultivation in the study area.

Sr. No.	Inputs	CP		HS		SS	
		No./Qty	Value (Rs.)	No./Qty	Value (Rs.)	No./Qty	Value (Rs.)
1.	Preparatory tillage	4.35	4253 (3.7)				
2.	Pre-sowing irrigation		745.4 (0.66)				
3.	Seed (kg)	125.20	2933.69 (2.60)	105.69	2252.92 (2.22)	103.60	2230.90 (2.21)
4.	Seed Treatment		146.97 (0.13)		172.43 (0.17)		158.26 (0.15)
5.	Sowing		1201.98 (1.06)		2883.38 (2.84)		3112.20 (3.08)
6.	Ridging		279.53 (0.24)				
7.	FYM (qtls)	75.04	2951.41 (2.62)				
8.	Fertilizer Nutrients						
	(a) Urea (Kg)	292.14	1734.12 (1.54)	296.23	1812.33 (1.79)	291.23	1792.33 (1.77)
	(b) DAP (Kg)	131.60	3290.47 (2.92)	139.10	3326.33 (3.2)	139.60	3354.47 (3.32)
	(c) Potash (Kg)	18.82	217.84 (0.19)				
	(d) Zinc Sulphate (Kg)	7.56	346.73 (0.30)	6.65	209.35 (0.20)	12.39	417.15 (0.41)
	Total fertilizer investment		5589.18 (4.9)		5348.01 (5.28)		5563.95 (5.5)
9.	Fertilizer Application cost		622.21 (0.55)		602.65 (0.59)		596.91 (0.59)
10.	Irrigation	4.75	3227.36 (2.86)	5	2616.29 (2.58)	4	2812.93 (2.78)
11.	Hoeing/ Weeding						
	(a) Chemical		1843.38 (1.6)		1630.83 (1.61)		1429.03 (1.41)
12.	Weedicides application cost		884.83 (0.78)		877.93 (0.86)		792.27 (0.78)
13.	Pesticide cost		538.72 (0.47)		475.24 (0.46)		530.38 (0.52)
14.	Pesticide application cost		363.84 (0.32)		302.73 (0.29)		330.33 (0.32)
15.	Harvesting		3738.83 (3.32)		3107.93 (3.06)		3162.28 (3.130)
16.	Wheat straw making		2088.73 (2.4)		2196.92 (2.13)		2268.22 (2.22)

17.	Miscellaneous		739 (0.65)		952.33 (0.94)		754.83 (0.74)
18.	Total (1 to 16)		36181.33 (32.15)		26419.10 (26.1)		26742.98 (26.5)
19.	Interest on working capital @ 7-8 percent		2427.93 (2.15)		2082.20 (2.0)		1928.36 (1.91)
20.	Variable cost (A)		38575.26 (34.28)		28501.3 (28.15)		28671.34 (28.43)
21.	Transportation		1539.93 (1.36)		1397.72 (1.38)		1385.33 (1.37)
22.	Management charges @9-10 percent		3705.93 (3.29)		3166.22 (3.12)		2674.39 (2.87)
23.	Risk factor @ 9-10 percent		3705.87 (3.29)		3166.79 (3.12)		2674.45 (2.87)
24.	Rental value of land		65000 (57.76)		65000 (64.22)		65000 (64.46)
25.	Total Fixed cost (B)		73951.73 (65.71)		72710.79 (78.83)		72158.17 (71.56)
26.	Total cost (A+B)		112526.99 (100)		101212.09 (100)		100829.51 (100)

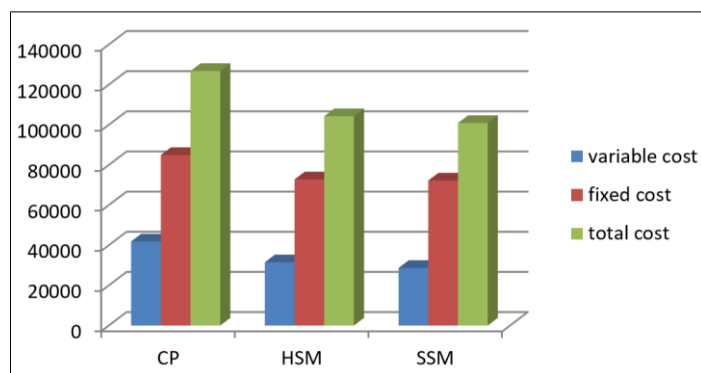


Fig 1.1: Comparative cost structure of Conventional method, happy seeder and Super seeder method of wheat growers in Kaithal district of Haryana (Rs./ha)

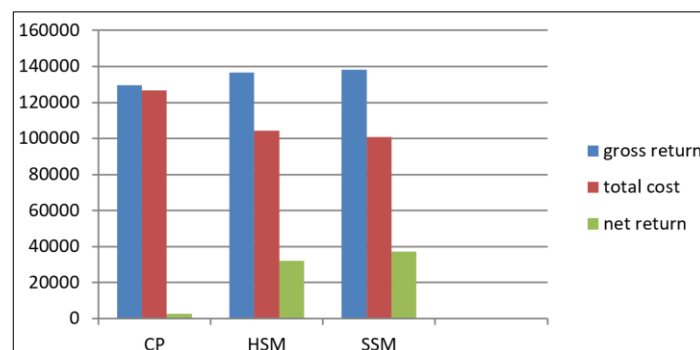


Fig 1.2: Returns from wheat cultivation in Kaithal district of Haryana during 2021-22

Table 1.2: Returns from wheat cultivation in Kaithal district of Haryana

S. No.	Particulars	CT		HS		SS	
		No./Qty.	Value (Rs.)	No./Qty.	Value (Rs.)	No./Qty.	Value (Rs.)
1.	Production (qtl.)						
	(a) Main product	51.45	103671.75	54.73	110280.95	55.43	111691.45
	(b) By product		12745.38		11938.83		11284.74
2.	Gross returns		116426.13		122219.78		122976.19
3.	Returns over variable cost		77850.87		93718.48		94304.85
4.	Net returns		3899.14		21007.69		22146.68
5.	B:C Ratio		1.034		1.207		1.22

Profitability from wheat cultivation in Kaithal district of Haryana is presented in Table 1.2. Per hectare gross returns were found to be approximately same for super seeder and happy seeder i.e. Rs.122976.19 and Rs.122219.78 respectively and for Conventional method it was estimated to be Rs. 116426.13 per hectare. Whereas, higher net returns were found to be in case of super seeder method i.e. Rs.22146.68 per hectare in comparison to happy seeder method (Rs. 21007.69 /ha) and conventional method (Rs. 3899.14/ha) due to higher production and lower cost of super seeder compare to happy seeder method and conventional method. As far as benefit cost ratio is concerned, Super seeder was observed to be comparatively more profitable with B:C ratio of 1.22 over HS and CP which have B:C ratio of 1.207 and 1.03, respectively. Based on the B:C ratio in Kaithal it was found that super seeder techniques are more beneficial comparatively happy seeder and also found that conventional method of wheat cultivation was least beneficial.

Cost of cultivation for Conventional Practices (CP), Happy Seeder Technique (HST) and Super Seeder Techniques (SST) in Sangrur district of Punjab

Cost of wheat cultivation under Conventional Practices (CP), Happy Seeder Technique (HST) and Super Seeder Technique

(SST) of wheat in Sangrur district of Punjab is presented in Table 1.3. Per hectare total cost of cultivation of conventional practice for wheat crop i.e. Rs.126817.48/ha was estimated to be higher as compared to happy seeder and super seeder techniques which have Rs.104288.37 and Rs.100903.93 respectively. The share of variable cost and fixed cost in total cost of conventional method of wheat were 33.01 percent (Rs.41870.43/ha) and 66.98 percent (Rs. 84947.05) respectively. In case of happy seeder technique of wheat the share of variable cost and fixed cost were found to be 30.20 percent (Rs. 31500.21/ha) and 69.79 percent (Rs. 72788.16/ha). Similarly in case of super seeder technique of wheat the share of variable cost and fixed cost estimated to be 28.41 percent (Rs 28671.34/ha) and 71.58 percent (Rs. 72232.59/ha). In case of Conventional Practices (CP), the highest share of variable cost was on fertilizer 5.92 percent followed by harvesting 2.89, irrigation 2.70 percent and seed 2.47 percent, while in fixed cost, maximum cost was incurred on rental value of land 51.25 percent (Rs.65000/ha) followed by risk factor and management charges which were 3.30 percent each (Rs. 4187.04 /ha) of total cost. In case of happy seeder technique, maximum variable cost incurred was on total fertilizer investment 6.75 percent followed by harvesting 2.91 percent, sowing 2.88 percent and irrigation 2.57 percent of total cost. Whereas in fixed cost

highest share were incurred on rental value of land 63.32 percent (Rs.65000/ha) followed by risk factor and management charges 3.02 percent each (Rs.3150.22/ha) of total cost. Similarly in case super seeder technique of wheat cultivation maximum variable cost was incurred on total fertilizer investment 6.9 percent followed by sowing 3.08 percent, harvesting 3.07 percent,

irrigation 2.82 percent and seed 2.21 percent of total cost. Whereas, in reference to fixed cost, highest share was incurred on rental value of land 64.41 percent (Rs.65000/ha) followed by risk factor and management charges which were 2.84 percent (Rs.2867.13/ha) each of total cost.

Table 1.3: Cost of cultivation in Conventional Practices (CP), Happy Seeder Technique (HST) and Super Seeder Techniques (SST) in Sangrur district of Punjab

Sr. No.	Inputs	CP		HS		SS	
		No./Qty	Value (Rs.)	No./Qty	Value (Rs.)	No./Qty	Value (Rs.)
1.	Preparatory tillage	4.30	5104 (4.02)				
2.	Pre-sowing irrigation		765.4 (0.60)				
3.	Seed (kg)	117.20	3133.69 (2.47)	102.69	2152.89 (2.05)	103.60	2230.90 (2.21)
4.	Seed treatment		156.96 (0.12)		162.75 (0.15)		158.26 (0.15)
5.	Sowing		1221.88 (0.96)		3007.57 (2.88)		3112.20 (3.08)
6.	Ridging		258.65 (0.20)				
7.	FYM (qtls)	70.04	2551.68 (2.01)				
8.	Fertilizer nutrients						
	(a) Urea (Kg)	343.14	2067.85 (1.62)	350.23	2107.76 (2.02)	337.23	1984.84 (1.97)
	(b) DAP (Kg)	165.64	4141.0 (3.26)	172.10	4302.57 (4.12)	173.84	4346.64 (4.30)
	(c) Potash (Kg)	29.85	746.25 (0.58)				
	(d) Zinc sulphate (Kg)	11.55	556.73 (0.43)	12.65	632.63 (0.60)	13.39	669.68 (0.66)
	Total fertilizer investment		7511.83 (5.92)		7042.96 (6.75)		7001.16 (6.9)
9.	Fertilizer application cost		752.69 (0.59)		736.83 (0.70)		721.52 (0.71)
10.	Irrigation	4.75	3427.55 (2.7)	5	2685.76 (2.57)	4	2846.75 (2.82)
11.	Hoeing/weeding						
	(a) Chemical		2147.38 (1.69)		2040.76 (1.95)		1953.73 (1.93)
12.	Weedicides application cost		954.65 (0.75)		903.62 (0.86)		865.76 (0.85)
13.	Pesticide cost		653.97 (0.51)		742.73 (0.71)		762.82 (0.75)
14.	Pesticide application cost		536.77 (0.42)		492.73 (0.47)		482.53 (0.477)
15.	Harvesting		3676.83 (2.89)		3036.87 (2.91)		3103.52 (3.07)
16.	Wheat straw making		2178.86 (1.70)		2583.74 (2.35)		2634.84 (2.58)
17.	Miscellaneous		864 (0.68)		849.63 (0.81)		748.84 (0.74)
18.	Total (1 to 16)		39131.25 (30.85)		29439.45 (28.22)		29622.83 (29.35)
19.	Interest on working capital @ 7-8 percent		2739.18 (2.15)		2060.76 (1.97)		2073.56 (2.05)
20.	Variable cost (A)		41870.43 (33.01)		31500.21 (30.20)		28671.34 (28.41)
21.	Transportation		1572.97 (1.23)		1487.72 (1.42)		1498.33 (1.48)
22.	Management charges @9-10 percent		4187.04 (3.30)		3150.22 (3.02)		2867.13 (2.84)
23.	Risk factor @ 9-10 percent		4187.04 (3.30)		3150.22 (3.02)		2867.13 (2.84)
24.	Rental value of land		65000 (51.25)		65000 (62.32)		65000 (64.41)
25.	Total Fixed cost (B)		84947.05 (66.98)		72788.16 (69.79)		72232.59 (71.58)
26.	Total cost (A+B)		126817.48 (100)		104288.37 (100)		100903.93 (100)

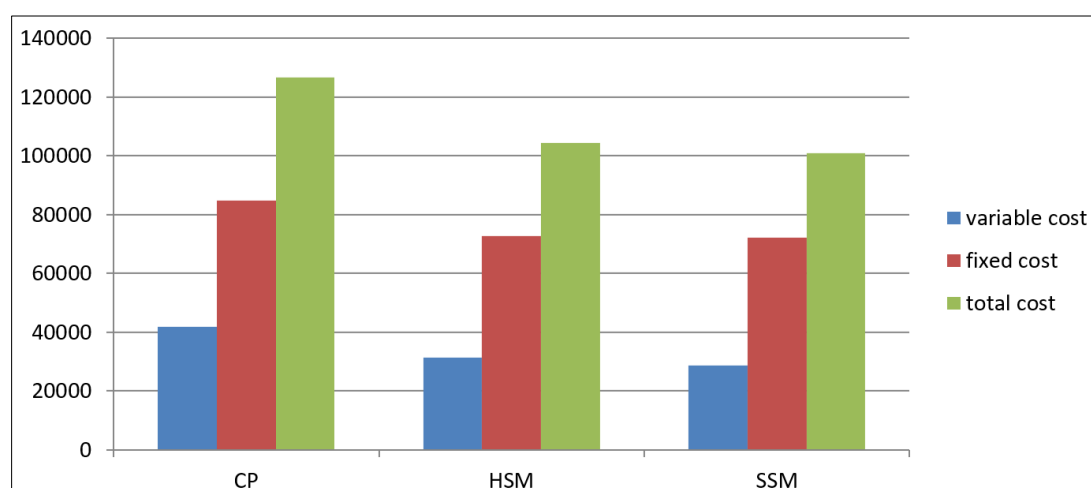
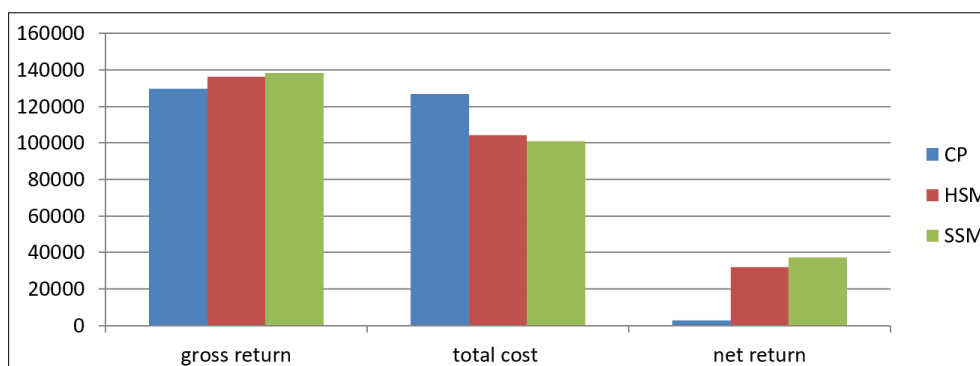


Fig 1.3: Comparative cost structure of CP, Happy seeder and Super seeder methods of wheat growers in Sangrur district of Punjab (Rs./ha.)

Table 1.4: Returns from wheat cultivation in Sangrur district of Punjab during 2021-22(Rs./ha.)

S. No.	Particulars	CT		HS		SS	
		No./Qty.	Value (Rs.)	No./Qty.	Value (Rs.)	No./Qty.	Value (Rs.)
1.	Production (Qtl.)						
	(a) Main product	57.50	115876.20	61.39	123694.4	62.44	125809
	(b) By product		13798.85		12768.57		12465.32
2.	Gross returns		129675.05		136462.97		138274.32
3.	Returns over variable cost		87804.62		104962.76		109602.98
4.	Net returns		2857.57		32174.60		37370.30
5.	B:C ratio		1.02		1.30		1.37



Profitability from wheat cultivation in Sangrur district of Punjab is presented in Table 1.4. Per hectare gross returns were estimated to be higher (Rs. 138274.32) in Super Seeder Method (SSM) as compare to happy seeder method (136462.97) and conventional method (129675.05) Whereas, net returns were found higher in case of Super seeder technique *i.e.* Rs. 37370.30 per hectare in compare to happy seeder technique (Rs. 32174.60 ha). It was found that net return of conventional method was very low *i.e.* only Rs.2857.57 it was due to high cost found in study compare to HST and SST. As far as benefit cost ratio is concerned super seeder was observed to be comparatively more profitable with B:C ratio of 1.37 over HSM and CP with B:C ratio of 1.30 and 1.02, respectively.

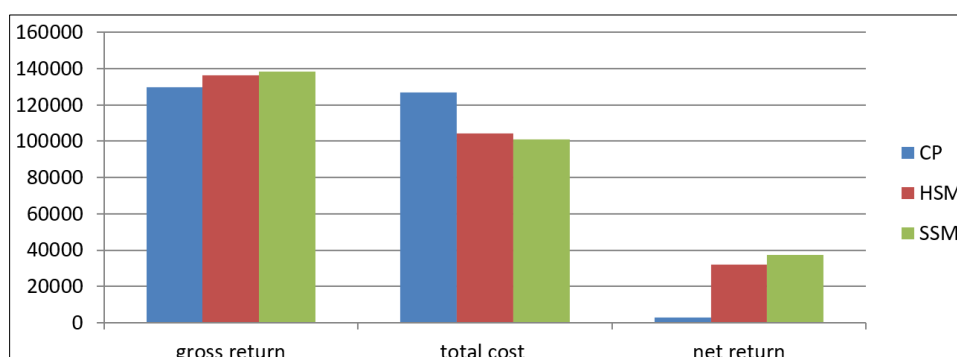
Cost of cultivation in Conventional Practices (CP), Happy Seeder Technique (HST) and Super Seeder techniques in Delhi

Cost of wheat cultivation under conventional practices (CP), Happy Seeder Technique (HST) and super seeder techniques (SST) of wheat crop in Delhi is presented in Table 1.5. Per hectare total cost of cultivation in conventional practice of wheat (Rs.117599.46/ha) was found to be higher as compared to happy seeder and super seeder techniques *i.e.* Rs. 108149.61 and Rs.107176.17, respectively. The share of variable cost and fixed cost in total cost of conventional practices of wheat were 29.51 percent (Rs.34704/ha) and 70.48 percent (Rs.82895.46) respectively. In case of happy seeder technique of wheat sowing

the share of variable cost and fixed cost were found to be 24.50 percent (Rs. 26502.84/ha) and 75.49 percent (Rs. 81646.77/ha) respectively. Similarly in case of super seeder technique of wheat sowing the share of variable cost and fixed cost found to be 24.28 percent (Rs. 26023/ha) and 75.71 percent (Rs. 81153.17/ha) respectively. In case of Conventional Practices (CP) the highest share of variable cost was on fertilizer 4.72 percent followed by harvesting 3.14, prepatry tillage 3.08 percent, chemicals 2.39 and seed 2.29 percent. While in fixed cost, maximum cost was incurred on rental value of land 63.77 percent (Rs.75000/ha) followed by risk factor and management charges which were 2.95 percent each (Rs. 3470.4 /ha). In HST, maximum variable cost incurred was on total fertilizer investment 4.27 percent, followed by harvesting 3.22 percent, sowing 2.66 percent, irrigation 2.40 percent and agri-chemicals 2.23 percent of total cost. Whereas, in fixed cost, highest share were incurred on rental value of land 69.34 percent (Rs.75000/ha) followed by risk factor and management charges 2.63 percent each (Rs. 2850.1/ha) of total cost. Similarly in case super seeder technique of wheat sowing maximum variable cost was incurred on total fertilizer cost 4.4 percent followed by harvesting 2.96 percent, sowing 2.90 percent, seed 2.27 percent and irrigation 2.08 percent of total cost. Whereas, in reference to fixed cost, highest share was found on rental value of land 69.97 percent (Rs.75000/ha) followed by risk factor and management charges which were 2.42 percent (Rs. 2602.30/ha) each of total cost.

Sr. No.	Inputs	CP		HS		SS	
		No./Qty	Value (Rs.)	No./Qty	Value (Rs.)	No./Qty	Value (Rs.)
1.	Preparatory tillage	3.43	3624.37 (3.08)				
2.	Pre-sowing irrigation		745.4 (0.63)				
3.	Seed (kg)	114.63	2703.73 (2.29)	102.69	2463.52 (2.27)	102.52	2442.62 (2.27)
4.	Seed treatment		0	0	0	0	0
5.	Sowing		1201.98 (1.02)		2883.38 (2.66)		3112.20 (2.90)
6.	Ridging		279.53 (0.23)				
7.	FYM (qtls)	59.26	2442.25 (2.07)				
8.	Fertilizer nutrients						

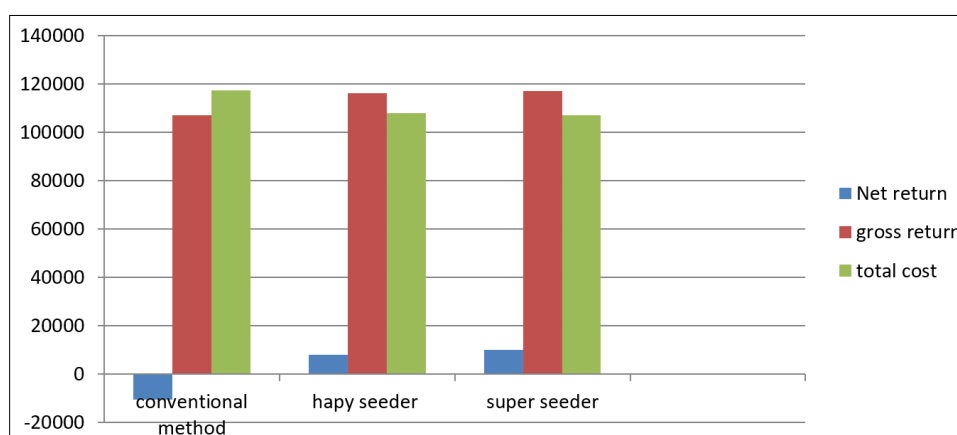
	(a) Urea (Kg)	168.36	1346.88 (1.14)	165.56	1322.36 (1.22)	157.46	1269.34 (1.18)
	(b) DAP (Kg)	128.37	3209.25 (2.72)	126.72	3168.56 (2.93)	132.22	3280.50 (3.08)
	(c) Potash (Kg)	69.45	833.40 (0.70)				
	(d) Zinc sulphate (Kg)	5.45	163.50 (0.13)	4.56	136.8 (0.12)	8.45	253.5 (0.23)
	Total fertilizer investment		5553.03 (4.72)		4627.72 (4.27)		4803.34 (4.4)
9.	Fertilizer application cost		622.21 (0.52)		602.65 (0.59)		596.91 (0.55)
10.	Irrigation	4.75	2837.63 (2.41)	5	2438.73 (2.40)	4	2236.32 (2.08)
11.	Hoeing/ Weeding						
	(a) Chemical		1274.28 (1.06)		973.73 (0.96)		848.38 (0.79)
12.	Weedicides application cost		483.83 (0.41)		380.6 (0.37)		372.83 (0.34)
13.	Pesticide cost		538.72 (0.45)		475.24 (0.46)		530.38 (0.5)
14.	Pesticide application cost		583.83 (0.45)		539.83 (0.53)		503.74 (0.46)
15.	Harvesting		3693.73 (3.14)		3263.3 (3.22)		3173.67 (2.96)
16.	Total chemical		2794.3 (2.39)		2283.37 (2.23)		2062.72 (1.87)
17.	Miscellaneous		638.73 (0.54)		836.63 (0.82)		637.83 (0.59)
18.	Total (1 to 16)		32433.72 (27.57)		24769.15 (22.90)		24320.94 (22.69)
19.	Interest on working capital @ 7-8 percent		2270.36 (1.93)		1733.84 (1.60)		1702.46 (1.58)
20.	Variable cost (A)		34704 (29.51)		26502.84 (24.50)		26023 (24.28)
21.	Transportation		954.66 (0.81)		946.57 (0.87)		948.57 (0.88)
22.	Management charges @9-10 percent		3470.4 (2.95)		2850.1 (2.63)		2602.30 (2.42)
23.	Risk factor @ 9-10 percent		3470.4 (2.95)		2850.1 (2.63)		2602.30 (2.42)
24.	Rental value of land		75000 (63.77)		75000 (69.34)		75000 (69.97)
25.	Total Fixed cost (B)		82895.46 (70.48)		81646.77 (75.49)		81153.17 (75.71)
26.	Total cost (A+B)		117599.46 (100)		108149.61 (100)		107176.17 (100)



Returns from wheat cultivation in Delhi during 2021-22

Profitability from wheat cultivation in Delhi is presented in Table below. Per hectare gross returns were estimated to be higher (Rs. 117253.59) in Super Seeder Technique (SST) as compare to Happy Seeder Technique (HST) (Rs. 116215.08) and conventional method (Rs. 107107.83). Whereas, net returns were found higher in case of super seeder technique *i.e.* Rs. 10077.42 per hectare in compare to happy seeder technique (Rs. 8065.47/ha). In this study it was found that net return for

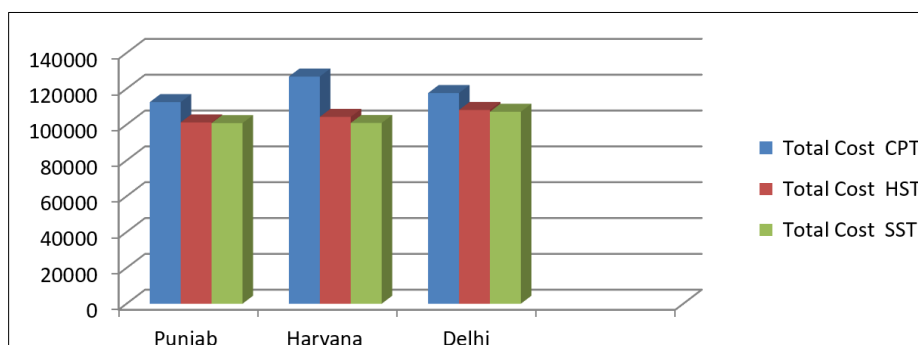
conventional practices were negative *i.e.* Rs. -10491.63/ha it was also found that negative net return due to very high rental value of land, high labor cost and low production compare to Kaithal and Sangroor. As far as benefit cost ratio is concerned, Super seeder was observed to be comparatively more profitable with B:C ratio of 1.09 over happy seeder techniques *i.e.* 1.07. For conventional practices because of negative net return, B:C ratio also found negative *i.e.* -1.08 under the study.



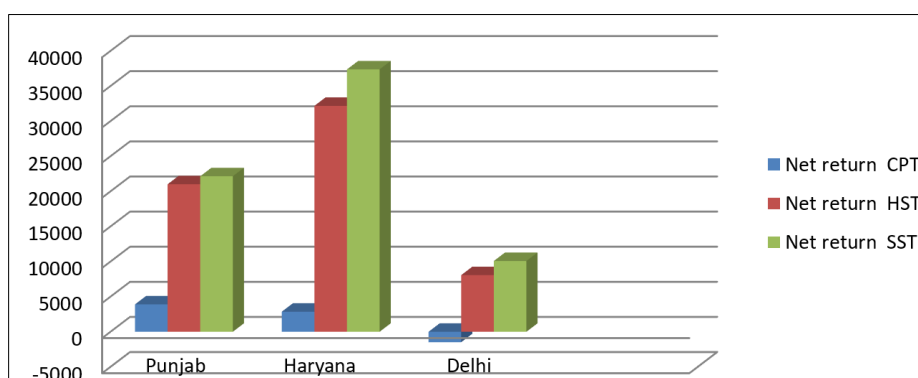
Comparative study of cost structure of wheat cultivation through CP, HST and SST in Punjab, Haryana and Delhi

Based on the comparative study of cost structure of wheat cultivation in Haryana, Punjab and Delhi it was found that Punjab had higher average cost in wheat cultivation through conventional practices and super seeder compare to Haryana and Delhi because of very high application of fertilizer, pesticides and irrigation in

Punjab. In this study it was found that Delhi had higher average cost for happy seeder compare to Punjab and Haryana. In Delhi average cost was higher in case of conventional method than Haryana not because of high application of fertilizer and pesticides but because of very high rental value of land and high wage rate of labor compare to Punjab and Haryana.



Comparative analysis of net return of wheat cultivation through CPT, HST and SST in Punjab, Haryana and Delhi.



Based on comparative analysis of net return of cultivation of wheat through conventional practices, happy seeder and super seeder. In this study it was found that in conventional practices the return was higher in Haryana and negative for Delhi due to low production and high average cost. In case of happy seeder techniques return found higher in Punjab i.e. 32174.60 rupees compare to Haryana i.e. 21007.69 rupees and lowest return found in Delhi i.e. 8065.47 rupees per hectare. In case of super seeder same trend was found as happy seeder. Based on result found in this study it was observed that wheat sowing through super seeder was more profitable in all state than happy seeder. It was also observed that conventional practices of wheat cultivation no more profitable in all state and in Delhi state cost of cultivation was more than total return.

Discussion

Cost of cultivation of wheat refers to the total expenses incurred in cultivating one hectare of land. The cost of cultivation is worked out in both input wise and operation wise together with their percentage to the total. A comparative analysis on the total cost of cultivation and its implication on Conventional Practices (CP), Happy Seeder Techniques (HST) and Super Seeder Technique (SST) have been done.

In Kaithal district of Haryana shows that per hectare total cost of cultivation in conventional technique of wheat (Rs. 112526.99/ha, Rs.126817.48/ha and Rs. 117599.46/ha) was estimated to be higher as compared to happy seeder (Rs 101212.09, Rs.104288.37 and Rs.108149.61/ha) and Super seeder technique

(Rs. 100829.51/ha, Rs.100903.93/ha and Rs.107176.17/ha). This was mainly because of higher expenses on preparatory tillage operations, and plant protection in conventional technique of wheat. Similar results were obtained by Grover *et al.* (2015) [3] in their study on comparative analysis of traditional /conventional planting system with zero tillage and in their study economic analysis of establishment techniques of wheat in Haryana.

As far as expenses on plant protection was concerns, it were estimated to be higher in Conventional Practices (CP) as compared to Happy Seeder Technique (HST) and Super Seeder Technique (SST) and in all the three location. The main reason behind that conventional practices of wheat is more susceptible to weed as in this technique weed gets more space and plant nutrition. Similar finding were observed by Singh and Kaur (2013) [6], Singh and Dhaliwal (2008) [5], Gupta *et al.* (2012) [7] and Harmeet and Kang (2017) [8] in their respective studies.

It was reported that expenditure on fertilizer was observed to be higher in Conventional Practices (CP) as compared to happy seeder technique and super seeder techniques. In Kaithal, Sangrur and North Delhi districts. These results are in agreement with the findings of Gupta *et al.* (2012) [9] and Akhter *et al.* (2016) [10] in their study.

5.5 Returns from Conventional Practices (CP), Happy Seeder Technique (HST) and Super Seeder Technique (SST)

It was evident from data presented per hectare gross returns was found to be higher in super seeder of wheat (Rs. 122976.19, Rs. 138274.32 and Rs. 117253.59/ha) as compared to happy seeder

(Rs.122219.78, Rs. 136462.97 and Rs. 116215.08 /ha) and Conventional Practices (CP) (Rs.116426.13, Rs.129675.05 and Rs. 107107.83/ha) in Kaithal, Sangrur and NCR region overall respectively. This is because of yield of wheat is slightly more in case of super seeder technique as compared to happy seeder and conventional practices and variable cost was high for conventional method.

While net returns were estimated to be higher in case of super seeder technique of wheat *i.e.* Rs. 22146.68, 37370.30 Rs. 10077.42/ha) as compared to happy seeder technique (Rs.21007.69, Rs. 32174.60 and Rs.8065.47/ha) and conventional practices (Rs. 3899.14, Rs. 2857.57 and Rs. 10491.63) in Kaithal, Sangrur and North Delhi districts respectively. These results are in confirmatory with Grover *et al.* (2015) [3] and Raju *et al.* (2016) [17] in their study.

Benefit cost ratio was found to be high in super seeder (1.22, 1.37 and 1.09) as compared to both happy seeder (1.207, 1.30 and 1.07) and conventional practices (1.03, 1.02 and -1.08) in Kaithal, Sangrur and Alipur respectively. Which indicated that super seeder and happy seeder are more economical and profitable than conventional techniques of wheat but adoption level of happy seeder and super seeder was less among farmers due to more germination problems, more insect-pest and disease infestation, not proper ridges in field and leveling problems. Similar trend were observed by Yogi *et al.* (2015) [11] and Singh (2018) [12] in their study. Sharma *et al.* (2020) also found super seeder being a new technology was used by very few farmers but it has also helped in getting yields higher than zero till drill and rotavators/disc harrows.

Conclusion

The benefit-to-cost ratio was observed to be significantly higher in the case of the super seeder (1.22, 1.37, and 1.09) when compared to both the happy seeder (1.207, 1.30, and 1.07) and conventional farming practices (1.03, 1.02, and -1.08) in the regions of Kaithal, Sangrur, and Alipur. This study suggests that both the super seeder and happy seeder offer greater economic viability and profitability than traditional wheat farming techniques. However, it should be noted that the adoption of happy seeder and super seeder among farmers remains relatively low due to challenges such as low germination issues, higher instances of insect-pest and disease infestations, inadequate field ridge formation, and leveling problems.

References

- Ministry of New and Renewable Energy, Government of India. National green hydrogen mission. New Delhi: Ministry of New and Renewable Energy; 2019 Jan. https://mnre.gov.in/img/documents/uploads/file_fl673581748609.pdf
- Consortium for Research on Agro ecosystem Monitoring and Modeling from Space (CREAMS) Laboratory, Division of Agricultural Physics, ICAR-Indian Agricultural Research Institute. CREAMS Laboratory. New Delhi: ICAR-Indian Agricultural Research Institute. <http://creams.iari.res.in/cms2/>
- Grover D, Kaur P, Sharma HR. Possible reasons and farmers awareness towards crop residue burning: an overview and a case study from Mirzapur Village of Kurukshetra District, India. *Environ We Int J Sci Technol.* 2015;10:75-85.
- Singh A, Kaur M, Kang JS, Geol A. Happy seeder and rotavator technology for in-situ management of paddy straw. *Int J Adv Res.* 2013;1:372-379.
- Singh RP, Dhaliwal HS, Humphreys E, Sidhu HS, Singh M, Singh Y, *et al.* Economic assessment of the Happy Seeder for rice-wheat systems in Punjab, India. In: Proceedings of the 52nd Annual Conference of the Australian Agricultural and Resource Economics Society; 2008.
- Singh A, Kaur M, Kang JS, Geol A. Happy seeder and rotavator technology for in-situ management of paddy straw. *Int J Adv Res.* 2013;1:372-379.
- Gupta R. The Happy Seeder: an agricultural solution to air pollution in South Asia. *Int J Agric Environ Biotechnol.* 2012;10(3):65-79.
- Singh H, Kang JS, Kaur J. Tillage and residue management for sustaining rice-wheat cropping system in Indo-Gangetic Plains: a review. *Pharma Innov J.* 2017;6(8):89-99.
- Gupta R. Causes of emissions from agricultural residue burning in north-west India: evaluation of a technology policy response. Kathmandu: South Asian Network for Development and Environmental Economics (SANDEE); 2012.
- Akhter S, Kotro R, Dar NA, Rasool R, Uddin RM. Resource conservation technology: a in rice wheat cropping system. *J Recent Trends Nat Sci.* 2016;1(2):23-46.
- Yogi V, Kar A, Bhardwaj S, Mehla V. Impact of zero tillage practices on economics of wheat cultivation in Haryana. *Int Res J Agric Econ Stat.* 2015;6(2):376-381.
- Singh J. Paddy and wheat stubble blazing in Haryana and Punjab states of India: a menace for environmental health. *Environ Qual Manag.* 2018;28(2):47-53.
- Awasthi A, Singh N, Mittal S, Gupta PK, Agarwal R. Effects of agriculture crop residue burning on children and young on PFTs in North West India. *Sci Total Environ.* 2010;408(20):4440-4445.
- Chendrashekhara S, Lokesh GB, Patila SS, Lokeshaa H. Factors influencing the adoption of paddy straw management practices by farmers of Karnataka (India). *Curr Agric Res J.* 2018;6(2):225.
- Fang Y, Xu K, Guo X, Hong Y. Identifying determinants of straw open field burning in northeast China: toward greening agriculture base in newly industrializing countries. *J Rural Stud.* 2020;74:111-123.
- Gupta PK, Sahai S, Singh N, Dixit CK, Singh DP, Sharma C, *et al.* Residue burning in rice-wheat cropping system: causes and implications. *Curr Sci.* 2004;1713-1717.
- Kafle S, Parajuli R, Euh SH, Oh KC, Choi YS, Adhikari K, *et al.* Potential biomass supply for agro-pellet production from agricultural crop residue in Nepal. *Energy Sources A Recovery Util Environ Eff.* 2016;38(1):149-153.
- Naresh RK, Singh SP, Kumar D, Pratap B. Experience with managing rice residues in intensive rice-wheat cropping system in North-western India. *Int J Life Sci Biotechnol Pharma Res.* 2013;2:85-96.
- Zhang H, Hu D, Chen J, Ye X, Wang SX, Hao JM, *et al.* Particle size distribution and polycyclic aromatic hydrocarbons emissions from agricultural crop residue burning. *Environ Sci Technol.* 2011;45(13):5477-5482.