Indian Journal of Ecology (2022) 49(5) (SI): 2016-2019
DOI: https://doi.org/10.55362/IJE/2022/3778

Manuscript Number: 3778
NAAS Rating: 5.79

Promotion of Natural Resource Management Technologies Through Frontline Demonstrations in Rice-Wheat Rotation in Punjab

K. Singh, P. Kumar, V.P. Kalra[1] and D. Singh*

Department of Extension Education, [1]School of Organic Farming
Punjab Agricultural University, Ludhiana-141 004, India
E-mail: dalbeer-coaext@pau.edu

Abstract: Findings of the frontline demonstrations revealed that happy seeder sown wheat gave a similar yield to the conventional sown wheat and had a lower cost of cultivation resulting in higher economic returns. In the case of direct seeded rice, it resulted in a lower yield than the transplanted rice and a further lower cost of cultivation, also. So direct seeded rice also resulted in higher economic returns as compared to the transplanted rice.

Keywords: Happy seeder, Direct seeded rice, Groundwater, Stubble, Burning

Punjab state experienced remarkable growth in agriculture due to the success of the green revolution. The early success of the Green Revolution in Punjab prompted the Government of India to target the state as a source of rice and wheat for the national food procurement and distribution system, at a guaranteed price. Subsequently, the state government of Punjab provided electricity for agricultural pumping at a flat rate, irrespective of the quantity of groundwater used. These two factors led to the establishment of a rice-wheat annual crop rotation. (Sharma et al 2012). The heavy reliance on inputs resulted in a slew of issues related to the sustainability of agriculture (Balkrishna et al 2022). With the advancement in mechanization, combine harvesters became popular among the farmers for the harvesting of rice and wheat, which causes the huge amount of rooted and uprooted remains of these crops in the field. Wheat stubble is used as animal fodder by farmers, but due to its high silica content, paddy stubble is not much popular for animal feed. On the other hand, the collection of loose paddy straw from the field is very costly and laborious that can delay the wheat sowing(Roy et al 2018). Thus, paddy straw management and sowing of wheat in this short time window is a challenging task for farmers resulting in the burning of paddy stubble in Punjab at the mass level and it causes the air pollution at a hazardous level during the early winters every year (Lohan et al 2018, Ravindra et al 2019, Keil et al 2020). The rice wheat rotation also demands a large amount of water which has been met by exploiting groundwater resources. The quantity and quality of underground water in the state are declining. Groundwater irrigation is a bigger source of irrigation today with a significant gain in its coverage area in the past four decades due to an increase in the number of tube wells (Balkrishna et al 2022). To meet the water demand in Punjab, 35.78 BCM of water is being withdrawn every year having an availability of only 21.58 BCM, leading to the 166 per cent extraction rate as a percentage of total percolation and at such withdrawal rate, groundwater resources of Punjab are likely to be used in 20-25 years (Anonymous 2018). Thus, the rice-wheat crop rotation has negative consequences on the natural resources of Punjab in terms of groundwater depletion, air pollution and loss of soil micro-organisms. To curb the problem of natural resource depletion, policymakers and researchers are trying to find suitable solutions. Among the various solutions, happy seeder for the sowing of wheat in standing stubble and direct seeded rice are the potential candidates. PAU adopted two villages in the Sangrur district of Punjab to evaluate the performance of these FLDs on happy seeder and direct seeded rice (DSR).

MATERIAL AND METHODS

Two villages Chatha Nanhera and Tranji Khera in district Sangrur were selected to evaluate and popularize the sustainable resource conservation technologies; with 1000 frontline demonstrations (FLDs) of happy seeder sown wheat for in-situ management of paddy stubble and 300 demonstrations of direct seeded rice were conducted from the year 2017-18 to 2021-22 (Fig. 1). The area under each demonstration was 0.4 hectare.

The necessary steps for selection of site, selection of farmers, the layout of demonstrations etc. were followed as suggested by Choudhary (1999) and Venkatasubramanian et al (2009). Farmers were provided with the trainings as per requirement and guidance through the field visits from time to time. The performance of FLDs was evaluated by comparing these with their counterfactuals i.e. happy seeder sown wheat with conventionally sown wheat and direct seeded rice with transplanted rice. Data regarding yield, cost of cultivation, and returns were collected for the FLDs and check plots. B:C ratio was calculated using the net returns and cost of cultivation.

RESULTS AND DISCUSSION

Performance of FLDs on happy seeder sown wheat: The happy seeder sown wheat gave a similar yield to conventional sown wheat (Fig. 2). In 2021-22, the wheat yield of wheat was reduced due to the heat wave, and the yield reduction in the happy seeder sown wheat was lesser than conventional sown wheat. The maximum yield was obtained in the year 2019-20, which was 56.85 q/ha. As happy seeder replaces the multiple operations (cultivating, planking, sowing) with a single operation i.e. direct sowing of wheat in standing stubbles, thus it was hypothesized to save the cost of cultivation in wheat. The findings revealed that the cost of cultivation can be reduced with the happy seeder. The saving in cost of cultivation ranged from Rs. 4346 per ha to Rs. 6785 per ha (Table 1). Further due to comparable or higher yield, happy seeder sown wheat also resulted in higher gross returns and ultimately higher net returns. The maximum increase in net returns was seen in the year 2021-22, which was Rs. 12507 per ha. As the result, happy seeder sown wheat has a higher benefit-to-cost ratio in all years.

Performance of FLDs on direct seeded rice: In order to sensitize the farmers regarding water saving, frontline demonstrations of direct seeded rice were also conducted in the project villages. There was no specific trend inthe yield of direct seeded rice and transplanted rice (Fig. 3). In the year 2017-18, 2018-19 and 2021-22, FLDs on direct seeded rice resulted in the lower yield than transplanted rice,

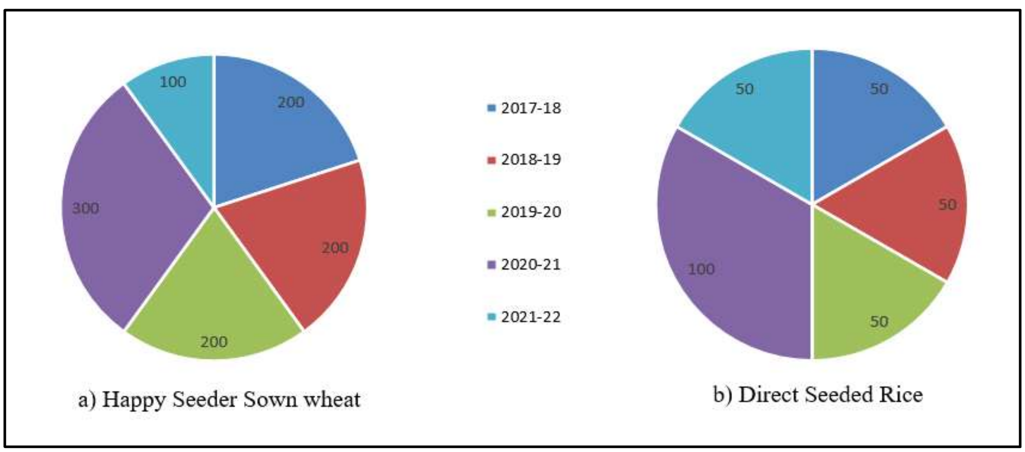

Fig. 1. Year-wise number of demonstrations of a) Happy seeder sown wheat b) Direct seeded rice

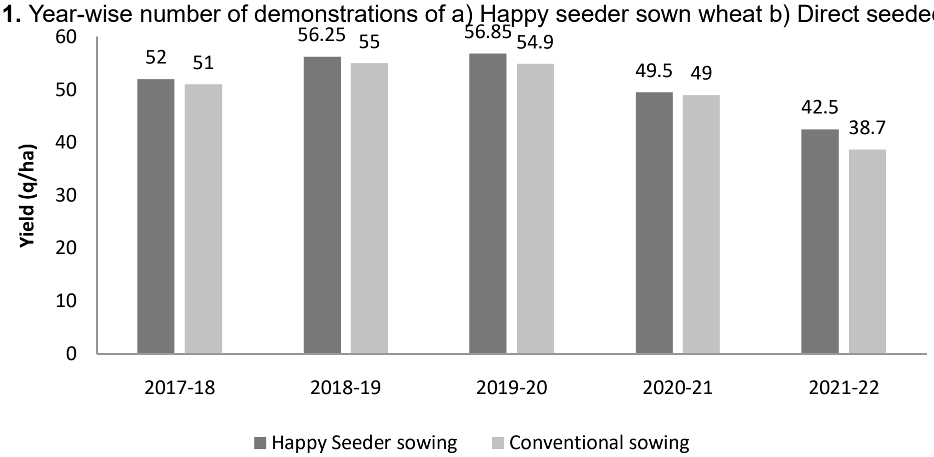

Fig. 2. Yield performance of happy seeder sown wheat vs conventionally sown wheat

whereas in the year 2019-20 and 2020-21, the yield obtained from the FLDs on direct seeded rice was higher than the transplanted rice. The maximum increase in yield of direct seeded rice over transplanted rice was observed in the year 2019-20, whereas maximum reduction was observed in the year 2021-22. The direct seeded rice saved

Table 1. Economic analysis of FLDs on happy seeder sown wheat

Particulars	Happy seeder sowing	Conventional sowing	Change
2017-18			
Cost of cultivation (Rs/ha)	21068	25414	-4346
Gross returns (Rs/ha)	90146	87971	+2174
Net returns (Rs/ha)	69078	62557	+6521
B.C ratio	3.28	2.46	+0.82
2018-19			
Cost of cultivation (Rs/ha)	22508	27325	-4818
Gross returns (Rs/ha)	103500	101200	+2300
Net returns (Rs/ha)	80993	73875	+7118
B.C ratio	3.60	2.70	+0.89
2019-20			
Cost of cultivation (Rs/ha)	22680	27845	-5165
Gross returns (Rs/ha)	104250	102230	+2020
Net returns (Rs/ha)	81570	74385	+7185
B.C ratio	3.60	2.67	+0.93
2020-21			
Cost of cultivation (Rs/ha)	23745	30530	-6785
Gross returns (Rs/ha)	97763	96775	+988
Net returns (Rs/ha)	74018	66245	+7773
B.C ratio	3.12	2.17	+0.95
2021-22			
Cost of cultivation (Rs/ha)	31400	36250	-4850
Gross returns (Rs/ha)	85638	77981	+7657
Net returns (Rs/ha)	54238	41731	+12507
B.C ratio	1.73	1.15	+0.58

Table 2. Economic analysis of FLDs on direct seeded rice

Particulars	Direct seeded rice	Transplanted rice	Change
2017-18			
Cost of cultivation (Rs/ha)	25380	32474	-7094
Gross returns (Rs/ha)	115217	116713	-1496
Net returns (Rs/ha)	89837	84239	+5598
B.C ratio	3.54	2.59	+0.95
2018-19			
Cost of cultivation (Rs/ha)	25420	32474	-7054
Gross returns (Rs/ha)	140280	140857.5	-577.5
Net returns (Rs/ha)	114860	108383.5	+6476.5
B.C ratio	4.52	3.33	+1.19
2019-20			
Cost of cultivation (Rs/ha)	26114	32326	-6212
Gross returns (Rs/ha)	141082	137984	+3098
Net returns (Rs/ha)	114968	105658	+9310
B.C ratio	4.40	3.27	+1.13
2020-21			
Cost of cultivation (Rs/ha)	29680	37514	-7834
Gross returns (Rs/ha)	144583	142902	+1681
Net returns (Rs/ha)	115903	107069	+8834
B.C ratio	4.81	3.81	+1.00
2021-22			
Cost of cultivation (Rs/ha)	37000	44450	-7450
Gross returns (Rs/ha)	153066	156364	-3298
Net returns (Rs/ha)	116066	111914	+4152
B.C ratio	3.14	2.52	+0.62

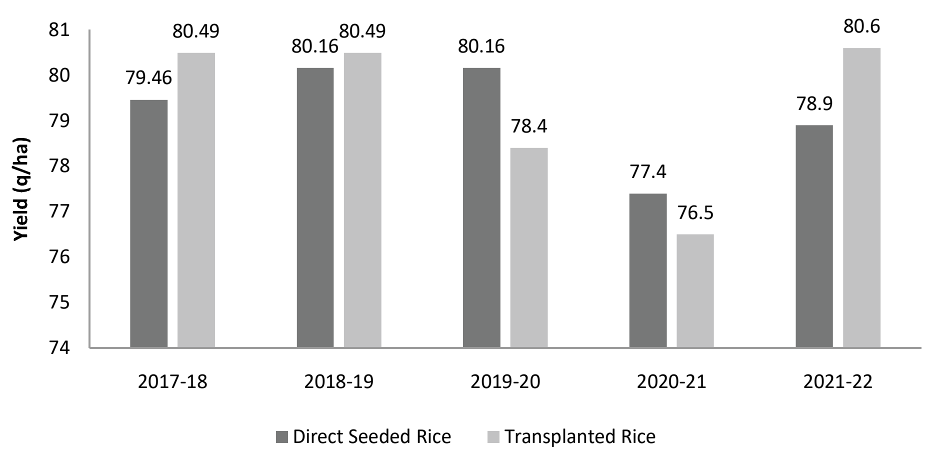

Fig. 3. Yield performance of direct seeded rice vs transplanted rice

the cost of cultivation in rice. The saving ranged from Rs. 6212 per ha in 2019-20 to Rs. 7450 per ha in the year 2021-22. The saving in the cost of cultivation in direct seeded rice was due to the labour cost for transplanting although expenses on the herbicides increase to some extent in DSR. The gross returns in DSR were also slightly lower than the transplanted rice in the year 2017-18, 2018-19 and 2021-22 due to lower yield, whereas higher in the remaining years. Due to large savings in the cost of cultivation, FLDs on DSR proved to fetch higher net returns in all years resulting in a higher benefit-to-cost ratio for DSR as compared to transplanted rice.

CONCLUSION

Happy seeder technology and direct seeded rice are the potential solutions to curb the problem of air pollution and groundwater depletion in Punjab, respectively. The happy seeder sown wheat had similar or higher yield and ultimately higher economic returns than the conventionally sown wheat. Direct seeded rice had a slightly lower yield, but due to the low cost of cultivation, it also resulted in higher economic returns. Thus, these technologies can also offer significant economic returns along with the conservation of natural resources.

REFERENCES

Anonymous 2018. *Groundwater resources of Punjab state*. Draft report. Water Resources & Environment Directorate, Water Resources Department, Punjab, Mohali and Central Ground Water Board North Western Region Chandigarh. Retrieved from https://dswcpunjab.gov.in/contents/docs/publications/Draft%20Report%20Punjab%20Groundwater%20Resources%202017.pdf on 25.07.2022

Balkrsihna A, Sharma G, Sharma N, Rawat N, Kumar A and Arya V 2022. Transition of agriculture from gloriuos past to challenging future: A serious concern. *Indian Journal of Ecology* **49:** 977-986.

Choudhary BN 1999. *Krishi Vigyan Kendra: A guide for KVK managers*. pp. 73-78. Division of Agricultural Extension, ICAR, New Delhi, India.

Keil A, Krishnapriya PP, Mitra A, Jat ML, Sidhu HS, Krishna VV and Shyamsundar P 2020. Changing agricultural stubble burning practices in the Indo-Gangetic plains: Is the Happy Seeder a profitable alternative? *International Journal Agricultural Sustainability* **19**: 128-151.

Lohan SK, Jat HS, Yadav AK, Sidhu HS, Jat ML, Choudhary M, Peter JK and Sharma PC 2018. Burning issues of paddy residue management in north-west states of India. *Renewable and Sustainable Energy Reviews* **81**: 693-706.

Ravindra K, Singh T and Mor S 2019. Emissions of air pollutants from primary crop residue burning in India and their mitigation strategies for cleaner emissions. *Journal of Cleaner Production* **208**: 261-273.

Roy P, Kaur M, Burman RR, Sharma JP and Roy TN 2018. Determinants of paddy straw management decision of farmers in Punjab. *Journal of Community Mobilization Sustainable Development* **13**: 203-210.

Sharma P, Krishnamurthy CK, Sidhu RS, Vatta K, Kaur B, Modi V, Fishman R, Polycarpou L and Lall U 2012.*Columbia water center white paper- Restoring groundwater in Punjab, India's bread basket:* Finding agricultural solution for water sustainability.

Venkatasubramanian V, Sajeev MV and Singha AK 2009. *Concepts, approaches and methodologies for technology application and transfer: A resource book for KVKs*. Pp 83-98. Zonal Project Directorate, Zone – III Indian Council of Agricultural Research, Umiam, Meghalaya.

~~*Received 12 July, 2020; Accepted 10 October, 2020*~~