Research Article

Indian Journal of Extension Education
Vol. 59, No. 3 (July–September), 2023, (132-137)

ISSN 0537-1996 (Print)
ISSN 2454-552X (Online)

Are Happy Seeder and PUSA Decomposer Potential Options for Sustainable Ways of Paddy Straw Management

Ragini Jambagi[1]*, Dharam Raj Singh[2], Alka Singh[3], P. Venkatesh[4], Manjeet Singh Nain[5] and Pradeep Panghal[6]

[1]Ph.D. Scholar, [2]Former Principal Scientist, [3]Professor and Head, [4]Senior Scientist, [6]Senior Research Fellow, Division of Agricultural Economics, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India
[5]Professor, Division of Agricultural Extension, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India
*Corresponding author email id: jambagiragini@gmail.com

ARTICLE INFO

Keywords: Happy seeder, PUSA decomposer, Paddy straw management, Stubble burning, Economic analysis

http://doi.org/10.48165/IJEE.2023.59325

Conflict of Interest: None

ABSTRACT

The study was undertaken to assess the effect of *in-situ* paddy straw management by the adoption of Happy Seeder and PUSA decomposer on the profitability in wheat cultivation and constraints to the adoption of these technologies using primary data collected from randomly selected 121 farmers in the Karnal district of Haryana in the year 2022. The results showed that the adoption of these technologies has reduced the cost and increased the profitability in wheat cultivation. However, the adoption of these technologies especially among small farmers remains limited. Financial constraints to the adoption of Happy Seeder and the longer duration for the decomposition of straw by PUSA decomposer were reported to be major hindrances in their adoption. Educating the farmers regarding the consequences of stubble burning and the potential benefits of adopting these technologies and addressing financial constraints and improving the efficacy of PUSA decomposer may be the potential options for sustainable management of paddy straw.

INTRODUCTION

One of the most significant cropping patterns for South Asia's food security is the rice-wheat (RW) cropping system. In 2019, the Indo-Gangetic Plains' rice-wheat cropping system stretched close to 13.5 million hectares of land (Gupta, 2019). Farmers find it difficult to diversify into other crops due to irrigation facilities at nominal electricity charges (Singh et al., 2008), assured procurement at minimum support price, availability of subsidized fertilizers and irrigation responsive high yielding cultivars, as well as crop adapted machinery (Chaudhary et al., 2019). Over the past sixty years, there has been an overall 2.53 per cent rise in crop residue availability in India (Devi et al., 2017). Among the whole, paddy contributes 154–235.8 million tonnes (MT), followed by wheat (131 MT) (Hiloidhari et al., 2014; Abraham et al., 2016). In these years, rice residue burning is becoming a matter of concern since burning of crop residue not only harms the environment but also account for the performance of soil-active herbicides and the loss of valuable nutrients. The burning of paddy straw in the field leads to in nutritional losses of up to 100% C, 90% N, 60% S, and 25% each P and K (Singh et al., 2020). Besides affecting the environment, it also has a negative influence on rural populations, such as respiratory difficulties, pneumonia and diminished visibility (Choudhary et al., 2022). Need of one and half months' time to the straw for proper decomposition (Rohilla et al., 2022), relative ease and economic feasibility of straw burning, unavailability of labour for harvesting operations, paucity of equipment, time consuming and expensive manual harvesting, short window between paddy and wheat (Kadhian et al., 2021) and poor industrial demand for paddy stubble (Roy, 2016) are the reasons forcing the farmers to practice burning. Approximately 30 per cent of the pollution in

Received 03-05-2023; Accepted 28-06-2023

and around Punjab and Haryana is caused by burning crop leftovers (Liefferink, 2020), where farmers burn an estimated 23 million tons of straw waste from rice harvests every year (Kumar et al., 2019). Since most of the farmers in Haryana raise late-maturing, fine-grained rice, which causes wheat to be sown later than usual forces them to burn (Tripathi et al., 2013). To solve the problem of burning, there are various alternative ways which are eco-friendly and also manages paddy straw at proper time without delaying in sowing operation of wheat crop (Kaur et al., 2021). Adoption of these alternatives like sowing the wheat with Happy Seeder not only prevents burning but also have indirect benefits like timely sowing, increased yield and reduction in cost of cultivation of wheat due to savings in many inputs. Also the stubble acts as manure and compost for the crops, thus use of decomposer improves soil fertility and productivity, requiring less fertilizer in the future (Ranjan et al., 2021).

METHODOLOGY

Karnal district of Haryana was purposively selected for the study as the district accounted for the highest paddy area burnt in 2021. Further, all 5 tehsils were considered and proportionate sampling was followed to decide the number of farmers. A cluster of villages was selected randomly and lists of Happy Seeder user farmers were procured/ prepared and adopters were selected randomly and almost same number of non-adopters was also selected randomly from the same villages. And primary data were collected from a total number of 121 farmers comprising 59 Happy Seeder adopter and 62 non-adopters. A total of 66 farmers were also applied PUSA decomposer for *in-situ* straw management. Eight custom hiring centers and 10 Happy Seeder service provider farmers were also interviewed. Selected farmers were classified as small (less than 2 ha), semi-medium (2 to 4 ha), medium (4 to 10 ha) and large (more than 10 ha) to study the inclusiveness of adoption of these technologies. Cost and return concepts, Partial budgeting and Garrett Ranking technique were used to attain the objectives.

The basis of cost of cultivation was the standard one as given by Commission for Agricultural Costs and Prices (CACP), Ministry of Agriculture and Farmers Welfare. Total cost has been segregated as Cost A1, Cost A2, Cost B1, Cost B2, Cost C1, Cost C2, Cost C3 and Cost A2+ Family labour. The returns is calculated as Gross income= Grain yield x grain price + straw yield x straw price, Income over Cost A2 +family labour = Gross income-(Cost A2 + imputed wages of family labour) and Net income = Gross income –Cost C3

The partial budget weighs the advantageous and disadvantages of adoption of Happy Seeder in wheat cultivation. We have calculated additional income in terms of enhanced yield and reduced cost (ploughing, seed, human labour and irrigation). Additional cost was observed to be as increased cost in Happy Seeder use, fertilizers and plant protection chemicals. Then, total added cost was subtracted from total added income to get net benefit of Happy Seeder adoption.

Stakeholders' (farmers, custom hiring centers and Happy Seeder service provider farmers) perception on constraints to the adoption of Happy Seeder and PUSA decomposer were recorded and analysed. Technical constraints involved in use of Happy Seeder like configuration problem, need of high HP tractor, which also needs more fuel, accessibility problems like timeliness in availability of machine, cost, cumbersome procedures in obtaining loan and subsidy etc. Problems which arise after sowing may be germination problem, less effective weedicides, weed infestation problems, pest attack etc. The problems faced by custom hiring centers and individual farmers for providing services of Happy Seeder to farmers were also recorded. The perceptions were analysed using Garrett Ranking technique and frequency distribution.

RESULTS AND DISCUSSION

Among the 121 sample farmers, 49 and 51 per cent were adopters and non-adopters of Happy/Super Seeders, respectively. The average size of land holding was 9.4 and 6.1 ha for adopters and non-adopters of Happy Seeders. The proportion of lessee farmers were almost same across Happy Seeder adopters and non-adopters, however, share of leased-in land was more (26%) on non- adopters farms in comparison to adopters farms (19%). The adoption of PUSA decomposer was higher (57%) on non-adopter farms than Happy Seeders adopter farms (53%). The results showed that adoption of Happy/Super Seeder was good as 36 per cent paddy straw was in-situ managed by them (Figure 1). However about 46 per cent of the paddy straw was still burnt and a meager quantity was used for animal feed, to incorporate on field, mushroom production, fuel purpose and for other things.

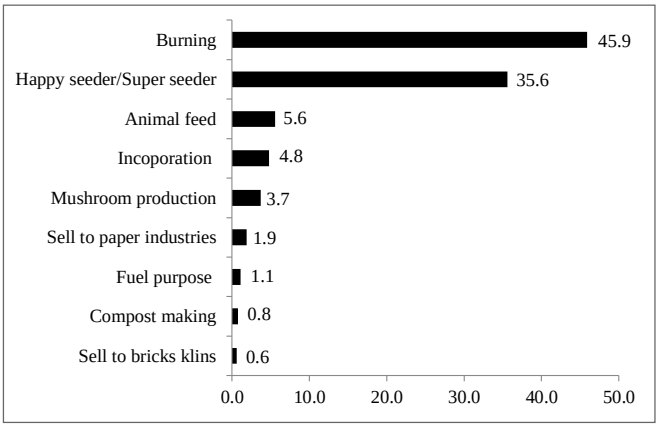

Figure 1. Methods of handling paddy straw in the region (%)

Cost of cultivation of wheat on Happy Seeder adopter and non-adopter farms

Happy Seeder adopter and non-adopter farmers incurred a total input cost of Rs. 47,145 and Rs. 49,015 per ha in wheat cultivation (Table 1). Total input costs were found to be increasing with increase in farm size on both types of farms. The higher input expenditure in conventional cultivation was due to higher expenditure on machine, irrigation and seed. On the other, fertilizer and plant protection chemicals uses were found to be more on Happy Seeder adopter than non-adopter farms. Compared to conventional technology, Happy Seeder adopters incurred higher expenditure on plant protection chemicals owing to the higher incidence of rats, slugs, and pink army worms. These results can

be supported by the findings of Tripathi et al., (2013) who states that adopters have saved 6.68 per cent human labour, 46.30 per cent machine labour, and 17.65 per cent irrigation water when compared to the conventional method.

The different costs in wheat cultivation were calculated using costs concepts for adopter and non-adopter farms (Table 2). Average cost A1 incurred was Rs. 44,365 and 47,374 per ha on adopter and non-adopter farms and increasing with farm size. Cost A2 was quite high (Rs. 66,194 per ha) on non-adopters than adopter farms (Rs. 57,379 per ha) due to a more proportion of wheat cultivation was undertaken on leased-in land. Increase in cost B2 was also very high because of high imputed rental value of owned land in the study area. The total cost of cultivation (Cost C3) were observed to be Rs. 1,32,812 and Rs. 1,39,260 per ha on adopter and non-adopter farms. The paid-out cost of cultivation (Cost A2 + family labour) was found to be Rs. 61,693 and Rs. 71,077 per ha and paid-out cost of production was Rs. 1148 and Rs. 1428 per quintal of wheat grain production on adopter and non-adopter farms, respectively.

Profitability in wheat cultivation on Happy Seeder adopter and non-adopter farms

Realization of wheat yield on Happy Seeder adopter farms was 53.8 quintals per ha which was 4 quintals higher than non-adopter farms (Table 3). Realization of gross, farm business and family labour incomes were also higher on Happy Seeder adopter than non-adopter farms. Return over Cost A2+family labour which indicates income over all paid out cost and imputed value of family labour was Rs. 66,534 per ha for adopters which was Rs. 14,871 more than non-adopters which indicates the higher profitability due to Happy Seeder adoption. This finding is in accordance with Yogi et al., (2015) whose study indicates that net

Table 1. Input costs in wheat cultivation on Happy Seeder adopter and non-adopter farm

Particulars	Input costs (Rs/ha) of adopters					Input costs (Rs/ha) of non-adopters				
	Small	Semi-medium	Medium	Large	All	Small	Semi-medium	Medium	Large	All
Family labourwages	7350	5684	2899	1321	4314	8485	4607	4215	2227	4883
	(17.1)	(12.2)	(6.2)	(2.8)	(9.1)	(18.8)	(9.6)	(8.3)	(4.3)	(10.0)
Hired labour wages	2218	3939	6890	8573	5405	1834	5986	6778	9072	5917
	(5.1)	(8.5)	(14.8)	(18.0)	(11.5)	(4.1)	(12.4)	(13.3)	(17.5)	(12.1)
Machine charges	13980	15116	14730	14994	14994	14333	15830	16844	16747	15939
	(32.4)	(32.5)	(31.6)	(31.4)	(31.8)	(31.8)	(32.9)	(33.1)	(32.3)	(32.5)
Seed cost	3590	3791	3782	3881	3835	4153	4172	4327	4397	4262
	(8.3)	(8.2)	(8.1)	(8.1)	(8.1)	(9.2)	(8.7)	(8.5)	(8.5)	(8.7)
Fertilizer cost	5098	5108	5618	6002	5788	5097	5115	5672	5772	5414
	(11.8)	(11.0)	(12.0)	(12.6)	(12.3)	(11.3)	(10.6)	(11.1)	(11.1)	(11.0)
Irrigation charges	4305	5285	5082	5386	5256	5089	6145	6344	6606	6046
	(10.0)	(11.4)	(10.9)	(11.3)	(11.1)	(11.3)	(12.8)	(12.5)	(12.7)	(12.3)
PPC cost	5938	6871	6889	6788	6816	5467	5563	5939	6173	5786
	(13.8)	(14.8)	(14.8)	(14.2)	(14.5)	(12.1)	(11.5)	(11.7)	(11.9)	(10.8)
Total input cost	43093	46495	46644	47743	47145	45111	48175	50925	51848	49015

(Figures in parenthesis are percent share of respective cost in total cost).

Table 2. Cost of cultivation in wheat on Happy Seeder adopter and non-adopter farms

Particulars	Cost (Rs/ha) of adopters					Cost (Rs/ha) of non-adopters				
	Small	Semi-medium	Medium	Large	All	Small	Semi-medium	Medium	Large	All
Cost A1	38528	43974	46088	47232	44365	42018	46501	48500	50209	47374
Cost A2	41653	45421	57197	63221	57379	44943	51242	60415	89872	66194
Cost B2	108662	118996	119872	117929	116425	117472	122718	122410	124569	121717
Cost C3	127614	137148	135048	131176	132812	138552	140058	139287	139475	139260
Cost A2+FL	49003	51105	60096	64542	61693	53428	55849	64630	92099	71077
Cost A2+FL/(RS/qtl)	975	986	1126	1188	1148	1142	1167	1300	1802	1428

Table 3. Returns in wheat cultivation on Happy Seeder adopter and non-adopter farms

Particulars	Cost (Rs/ha) of adopters					Cost (Rs/ha) of non-adopters				
	Small	Semi-medium	Medium	Large	All	Small	Semi-medium	Medium	Large	All
Yield (qtl/ha)	49.3	50.8	52.4	54.3	53.8	46.8	47.8	49.7	51.1	49.8
Gross income	120529	124961	127269	129462	128227	116645	115949	122073	127501	122740
Income over Cost A2+FL	71525	73856	67173	64920	66534	63217	60100	57443	35402	51663
Net income	-7085	-12186	-7779	-1714	-4585	-21908	-24109	-17214	-11974	-16520

income has been found higher in Turbo Happy Seeder method, mainly due to lower cost of production compared to that in conventional method. However, realization of net income of this year (2022) was found to be negative on both the adopter and non-adopter farms, this may be due to decrease in wheat yield on account of heat stress at the time of grain maturity. However, negative net income realization was very low on Happy Seeder adopter than non-adopter farms. This may be the on account of less effect of terminal heat in paddy straw mulched farms under Happy Seeder cultivation.

Financial feasibility of Happy Seeder adoption

A financial viability of adoption Happy Seeder was assessed using partial budgeting approach and the results are presented in Table 4. It was observed that Happy Seeder adopter farmers realized additional income of Rs. 8223 on account of increased yield of approximately 4 quintal per ha. This method of wheat cultivation also reduces the cost by Rs. 8799 per ha which is due to saving in use of 32.7 hours of human labour (Rs. 2062), 4.4 number of ploughing for land preparation (Rs. 5520), 12 kg per ha of seed (Rs. 427) and irrigation of Rs 790 per ha. On the other hand, the method has also resulted in additional expenses of Rs. 6948 per ha due to an increase in the cost of some practices like sowing by Happy Seeder, increased usage of fertilizers, pesticides and rodenticides per ha. This analysis showed that adoption of Happy Seeder generated a net benefit of around Rs. 10,074 per ha in wheat cultivation. This result is consistent with the findings of Keil et al., (2021) who states that the Happy Seeder leads to significant savings in wheat production costs, amounting to 161 per quintal or approximately Rs. 8800 per ha.

Adoption and benefit of PUSA decomposer

PUSA decomposer is a new technology for paddy straw management. In our study, overall 66 sample farmers have adopted this technology and 46 per cent of Happy Seeder adopters have also adopted PUSA decomposer. The cost of application of this technology is very less (Rs. 20 per pouch of 4 capsules for one hectare with 10-12 tonnes of straw and labour cost of spraying). It was found that around a half of the users were fully satisfied with the use of technology and especially the large farmers are more satisfied than the small farmers (Table 5). Further, more than a half of the farmers were found partially satisfied with this technology. More dissatisfied farmers lied in the category of small (75%) and decreased to 36 per cent in large category. Burning was reported as the predominant practice by 53 percent of partially satisfied farmers. The farmers engaged in stubble burning were relatively higher in small and semi medium categories and less in medium and large farmers. Around one-third of partially satisfied farmers reported extra ploughing to manage paddy straw. Although more than a half of the farmers were reported to be not satisfied by the efficacy of PUSA decomposer, the realization of wheat yield was found to be more on PUSA decomposer adopter farms. PUSA decomposer adopters realized higher yield by 0.30 qtl per ha, which highlights potential economic advantage along with environmental and soil health advantages.

Constraints to adoption of Happy Seeder and PUSA Decomposer

Under accessibility of Happy Seeder by farmers, four major constraints were identified like high operational cost of Happy

Table 4. Partial budgeting of the Happy Seeder adoption

Additional income	Rs/ha	Reduced income	Rs/ha
Grain yield (4.00 qtl/ha)	8223	-	-
Total added income (A)	8223	Total reduced income (C)	-
Reduced cost	Rs/ha	Additional cost	Rs/ha
Human labour (32.7 hrs/ha)	2062	Human labour (7.5 hrs)	472
Ploughing (4.4 No./ha)	5520	Happy Seeder use	5070
Seed (12 kg/ha)	427	Fertilizer use	374
Irrigation per ha	790	Plant protection chemical	1032
Total reduced cost (B)	8799	Total added cost(D)	6948
Total gain (A+B)	17022	Total added cost (C+D)	6948
Net Benefit per ha (Total Gain –Total added cost)			10074

Table 5. Adoption of PUSA decomposer for straw management

Row Labels	Small	Semi-medium	Medium	Large	Grand Total
PUSA decomposer user (No.)	8	10	34	14	66
Fully satisfied (decomposed properly) (%)	25	50	47.10	64.30	48.50
Partially satisfied (not decomposed properly) (No.)	75	50	52.90	35.70	51.50
Straw management by partially satisfied farmers					
Burnt (%)	83.30	80	38.90	40.0	52.90
Manually cleaned (%)	16.60	-	22.20	-	14.70
Extra ploughing (%)	-	20	38.90	60.0	32.40

Source: Compiled from field survey, 2022

Seeders, delay in payment of subsidies, cumbersome procedure for availing subsidy, the lack of timely availability of Happy Seeders and the requirement of high power tractors to operate Happy Seeders. The higher weed infestation was identified as post-adoption constraints. Poor seed germination was not a major constraint hindering the adoption of Happy Seeder. The small farmers ranked the perceived bias of CHC to large farmers as an impediment in adoption of CHC technologies. These findings are similar with that of Chaudhary et al., (2019).

Custom hiring centers are key stakeholders in scaling up the adoption of CRM technologies. Examining the constraints faced by custom hiring centers for Happy Seeders would prove vital in enhancing the efficacy of custom hiring centers. The delay in disbursal of subsidies by government agencies was a major constraint hindering the operational efficacy of custom hiring centers. Custom hiring centers also rank difficulties in obtaining credit as a major constraint, while the seasonal nature of demand for Happy Seeders often affect the finances of these institutions. The lack of support from local Government institutions also limits the operational efficacy of custom hiring centers. Delay in return of equipment by farmers and farmers returning the equipment in poor condition were also ranked high among operational constraints of custom hiring center.

Farm households owning Happy Seeders rely on rental services of Happy Seeder as an alternative source of income and have emerged as prominent service providers. Among the sampled farm households, ten households were engaged in providing rental services to neighboring farm households. The disparity in subsidy amount given to CHC and farmers was ranked a major concern by farmers engaged in rental services. Custom hiring centers avail a subsidy of 80 per cent while farm are beneficiaries of 50 per cent subsidy. Nearly, 80 per cent of the households faced credit constraints, while 50 per cent reported an increase in wear and tear of machines on account of rental services. The delay in payment for rental services by kith and kin were deemed to affect the financial viability of rental services by nearly three fifth of the farmers.

PUSA decomposer user and aware-non user farmers' perceptions on adoption of PUSA decomposer were recorded and most of the respondents revealed that the need of extra irrigation and the time of about 25 days for proper decomposition as the major hindrance as they cannot wait and delay wheat sowing. Poor know how of this technology and accessibility were opined to be other factors for either poor or non-adoption or partial satisfaction after adoption of Pusa decomposer.

CONCLUSION

In-situ residue management of paddy straw by use of Happy Seeder has garnered satisfactory level of acceptability among the farmers. Although, Happy Seeder adoption led to considerable reduction in irrigation, machine and labour expenditure, adopters were found to have more expenditure on plant protection and fertilizers. The total cost of cultivation of wheat on Happy Seeder adopted farms was found to be lower than that of non-adopters and they realized more yield of about 4 quintal per ha. PUSA decomposer was adopted by a good proportion of farmers and generated additional yields. However, more than a half of the adopter farmers were found partially satisfied with the efficacy of PUSA decomposer. Therefore, educating the farmers by using multi-media and training camps regarding the consequences of stubble burning on environment and soil health and potential benefits of adoption of these technologies will help to reduce the menace of straw burning.

REFERENCES

Abraham, A., Mathew, A. K., Sindhu, R., Pandey, A., & Binod, P. (2016). Potential of rice straw for bio-refining: an overview. *Bioresource Technology*, *215*, 29-36.

Chaudhary, A., Chhokar, R. S., Yadav, D. B., & Sindhu, V. K. (2019). *In-situ* paddy straw management practices for higher resource use efficiency and crop productivity in Indo-Gangetic Plains (IGP) of India. *Journal of Cereal Research*, *11*(3), 172–198.

Choudhary, A., Kadian, K. S., & Meena, M. S. (2022). Assessment of farmers' perception about crop residue burning in Haryana. *Indian Journal of Extension Education*, *58*(1), 85–88.

Devi, S., Gupta, C., Jat, S. L., & Parmar, M. S. (2017). Crop residue recycling for economic and environmental sustainability: The case of India. *Open Agriculture*, *2*(1), 486-494.

Gupta, N. (2019). Paddy residue burning in Punjab: Understanding farmers' perspectives and rural air pollution. *Council on Energy, Environment and Water*, pp 21-23.

Hiloidhari, M., Das, D., & Baruah, D. C. (2014). Bioenergy potential from crop residue biomass in India. *Renewable and Sustainable Energy Reviews*, *32*, 504-512.

Kadian, K. K., & Meena, M. (2021). Reasons and awareness levels of farmers on residue burning in Indo-Gangetic plain of India: an exploratory research. *Journal of Agri Search*, *8*(1), 62-66.

Kaur, A., Kaur, P., & Kumar, P. (2021). Status of paddy straw management technologies in Punjab. *Indian Journal of Extension Education*, *57*(1), 78–83.

Keil, A., Krishnapriya, P. P., Mitra, A., Jat, M. L., Sidhu, H. S., Krishna, V. V., & Shyamsundar, P. (2021). Changing agricultural stubble burning practices in the Indo-Gangetic plains: Is the Happy Seeder a profitable alternative? *International Journal of Agricultural Sustainability*, *19*(2), 128–151.

Kumar, S., Sharma, D. K., Singh, D. R., Biswas, H., Praveen, K. V., & Sharma, V. (2019). Estimating loss of ecosystem services due to paddy straw burning in North-west India. *International Journal of Agricultural Sustainability*, *17(2*), 146-157.

Liefferink, J. D. (2020). India: the country of rice. An analysis to the opportunities for local farmers when the burning of paddy straw is avoided. *M.Sc. Thesis, Radboud University- Nijmegen School of Management*, Netherland.

Ranjan, S., & Sow, S. (2021). Sustainable Rice Straw Management-Challenges and Solution. *Agriculture and food: e-Newsletter, 3*(1), 26-28.

Rohilla, E., Sehgal, B., Rohila, A. K., & Malik, J. S. (2022). Awareness of paddy residue utilization in Karnal and Kurukshetra districts of Haryana state. *Indian Journal of Extension Education*, *58*(4), 180–183.

Roy, P., & Kaur, M. (2016). Awareness regarding alternative techniques of paddy straw management in Punjab and West Bengal- A comparative analysis. *Ecology, Environment and Conservation*, *22*(3), 1313-1316.

Singh, G., Singh, P., Sodhi, G. P. S., & Tiwari, D. (2020). Adoption status of rice residue management technologies in South-Western Punjab. *Indian Journal of Extension Education*, *56*(3), 76-82.

Singh, J., & Grover, D. K. (2006). Economics of wheat under different cropping systems. *Field Crops Research, 28*(6), 23-26.

Singh, R. P., Dhaliwal, H. S., Humphreys, E., Sidhu, H. S., Manpreet, S., Yadvinder, S., & Blackwell, J. (2008). Economic evaluation of the Happy Seeder for rice-wheat systems in Punjab, India. In: *Proceedings of the 52nd Australian Agricultural and Resource Economics Society Conference Canberra, Australia* (pp. 5-8).

Tripathi, R. S., Raju, R., & Thimmappa, K. (2013). Impact of zero tillage on economics of wheat production in Haryana. *Agricultural Economics Research Review*, *26*(1), 101-108.

Yogi, V., Kar, A., Bhardwaj, S., & Mehala, V. (2015). Impact of zero tillage practices on economics of wheat cultivation in Haryana. *International Research Journal of Agricultural Economics and Statistics*, *6*(2), 376–381.