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Constraints in Adoption of In-situ Paddy Straw Management Technologies in Punjab Agriculture

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Abstract

In-situ straw management is a practice of conserving the crop residue into the soil by retention or incorporation rather than burning it. The study was conducted among purposively selected 120 farmers from Moga and Ferozepur districts of Punjab to analyse constraints faced by them in adopting in-situ paddy straw management technologies i.e., Happy seeder, Super seeder and MB plough. Study revealed that difficulty in sowing of wheat crop, poor seed germination and higher rodent attack were the major technological constraints faced by the farmers. In financial constraints, high cost of machines and lesser amount of subsidy was faced by 80.00 per cent of farmers adopting super seeder whereas 77.50 percent respondents reported difficulty in availing it. Increase in sowing cost was also reported by farmers adopting MB plough technology (90.00%). General constraints like lower yield in the initial years, requirement of high horse power tractors and, non-availability of machines at peak time and untimely rains were also posing hindrances in adoption of in-situ straw management technologies. Understanding of the different technological, financial and general constraints faced by farmers may help in formulating suitable farming policies to check the paddy straw burning.

Keywords: Constraints, Residue, Management, Happy seeder, Super seeder, MB plough

JEL Classification: Q10, Q15, Q53, Q54

Introduction

One of the greatest issues for food security and securing the livelihoods of millions of agricultural households is the deterioration of natural resources combined with rising intensity of climate variability. India is an agrarian country and ranks as the second largest producer of rice and wheat in the world (GOI, 2018). With the year-round crop cultivation, large amount of crop residue is produced in rice-wheat cropping system. It is estimated that total 620 million tonnes of crop residue generated from food grains in India each year, of which rice and wheat accounting for about 192 and 120 million tonnes (Jain *et al,* 2014). Burning of this crop residue has become one of the most important issues affecting environmental quality in India. Residue burning becomes more common in northern India, particularly in Punjab, Haryana, and western Uttar Pradesh, contributing significantly to severe smog in the region (Bhadauriya *et al,* 2020; Mukherjee *et al,* 2018; Ravindra *et al,* 2019; Singh, 2018). Rice is being cultivated on 3.14 million hectares with a production of 12.67 million tonnes in Punjab (GOP, 2020). Stubble production was estimated to be 25.45 million tonnes in the state, out of which 49.53 per cent residue managed with in-situ or ex-situ straw management technologies (IARI, 2020).

Burning of rice residues in the fields, results in loss to environment and human health. Paddy residue burning produces a huge quantity of pollutants (RSPM, NOx, and SO_2) in a short amount of time, resulting in an acute environmental impact (Gadde *et al,* 2009; Mittal *et al,* 2009; Singh *et al,* 2015). One tonne of straw on burning releases 3 kg of particulate matter, 60 kg of CO, 1,460 kg of CO_2, 199 kg of ash and 2 kg of SO_2 (Gupta *et al,* 2004). It not only endangers health of human and animals, but it also depletes key nutrients like nitrogen, phosphorous, sulphur, and potassium from the top soil layer, making the land less fertile and unsuitable for agricultural production in the long terms (Lohan *et al,* 2018). As per estimates one tonne of straw contain approximately 400 kg of organic carbon, 5.5 kg of Nitrogen, 2.3 kg of Phosphorus, 25 kg of Potash, 1.2 kg of Sulphur and 50-70 per cent of micro nutrients are lost through straw burning thus costs more than Rs. 200 crores (Sidhu *et al,* 2007).

Even though farmers are aware of the negative impacts of straw burning on soil, air, and human health (Anuradha *et al,* 2021) but they found it the fastest and cheapest method to

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manage most of the crop residue (Kumar *et al,* 2015). From farmers' perspective, there are many compelling factors for straw burning including the short time window for wheat sowing (Anuradha *et al,* 2021; Lyngdoh and Dhaliwal, 2018; Nikam and Singh, 2020). The average time interval between the harvest of rice and sowing of wheat is nearly 15 days (Krishna *et al,* 2011). The delay of sowing wheat after first fortnight of November results in yield losses of one per cent per day (Brar *et al,* 2010). High cost of manual labour, lack of traditional use of crop residues, intensive cropping system and non-availability of buyers for rice straw can be some of the factors compelling farmers to burn crop residue left over after the harvest (Lyngdoh and Dhaliwal, 2018; Anuradha *et al,* 2021). The mechanized harvesting of rice using combine harvesters is a common practice that left a huge quantity of loose straw in the fields (Singh *et al,* 2020). Incorporating straw into the soil necessitates more tillage operations to sow wheat, thus, increasing the operation/sowing expenses (Singh *et al,* 2020). There are also issues in use of paddy straw as fodder and the presence of anti-nutritional factors like silicates and oxalates in rice straw with low nutritive value, poor palatability and limited ruminal degradation render paddy straw as non-maintenance type of fodder, so cannot support the nutrient requirement of the animals (Ganai *et al,* 2006; Ganai and Teli, 2010; Sharma *et al,* 2001; Soest, 2006).

National and state research system has made significant progress in the last two decades in developing and disseminating a variety of technologies for in-situ management of loose rice straw, including straw management system on combine harvesters, zero till drill, happy seeder, super seeder, reversible MB plough, rotavator, straw chopper and straw cutter-cum-spreader etc. From 2018-19, a Central Sector Scheme on 'Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh, and the National Capital Territory of Delhi' is also being implemented to address air pollution and subsidise machinery needed for in-situ management of crop residue. Custom Hiring Centres (CHCs) were formed under this scheme, and over 1.5 lakh crop residue management machines were distributed to these CHCs and individual farmers (PIB, 2021). Furthermore, in Punjab, the area under burn-free straw management has expanded from 6.15 lakh hectares in 2016 to 17.30 lakh hectares in 2020 (PAU, 2020). However, farmers still encountering different problems at field level to practice paddy straw management. The present investigation was planned and carried out to analyse the various constraints faced by the farmers in adoption of paddy straw management technologies.

Data Sources and Methodology

A farmer participatory project to assess adoption and impact of crop residue management technologies in rice-wheat cropping system is being carried out in four villages of each of Moga and Ferozepur districts from the year 2020. The present study was conducted purposively in these selected eight villages of Moga and Ferozepur districts to know the various constraints faced by farmers in the adoption of in-situ paddy straw management technologies. A sample of 40 farmers who have adopted Happy seeder technology was selected randomly with the representation of five farmers from each selected village. Similar sampling procedure were followed for selecting 40 farmers for each of super seeder and MB plough technologies. Thus, the total sample size of 120 farmers was selected from both districts for the present study. To understand the different constraints in the adoption of paddy straw management, a structured questionnaire was developed after reviewing relevant studies and discussion with the farmers. The interview schedule was pre-tested in a non-sample area to remove any ambiguities, and necessary modifications were made as per the response pattern of the farmers. The changes observed as a result of pre-testing were incorporated into the interview schedule. The responses to the constraints were measured on a dichotomous scale in the form of yes/no. Ranks were assigned in descending order according to the frequency and percentage of farmers facing a particular problem. Data was collected through personnel interviews with the respondents in the selected villages during the year 2021.

Results and Discussion

The constraints under the present investigation were considered as an impediment that hinders the farmers to adopt the in-situ straw management technologies within the study area. The results pertaining to various aspect-wise constraints faced by the farmers have been presented as under:

Technological Constraints

The respondents were asked to provide a dichotomous response to the identified technological constraints in the adoption of in-situ straw management technologies. The data in table 1 reported that difficulty in sowing the wheat crop was found to be the most serious constraint by a majority of the respondents and it turns out to be the most prominent constraint perceived by them in all the selected in-situ straw management technologies and ranked first. It might be due to the fact that happy seeder/super seeder machines sometimes get choked in fields where straw was not evenly spread or paddy crop has not been harvested with Super SMS fitted combine harvester. The large volumes of crop residue on the soil surface hinder machinery manoeuvring, thus affecting the sowing of wheat crop (Mandal *et al,* 2004). In happy seeder technology, about 90.00 per cent of respondents felt rodent attack as major problem and the same concern were put out by 65.00 and 37.50 per cent respondents adopting super seeder and MB plough for straw management, respectively. In comparison to crops sown with conventional tillage,

Table 1. Technological constraints faced by the farmers in the adoption of different paddy straw management technologies (n=120)

Particulars	Happy Seeder (n_1=40)		Super Seeder (n_2=40)		MB Plough (n_3=40)	
	f	Rank	f	Rank	f	Rank
Yellowing of wheat crop	24 (60.00)	IV	24 (60.00)	VI	31 (77.50)	III
Difficulty in sowing of wheat crop	37 (92.50)	I	36 (90.00)	I	35 (87.50)	I
Poor seed germination	30 (75.00)	III	31 (77.50)	II	8 (20.00)	VII
Difficulty in managing weeds	3 (7.50)	VII	21 (52.50)	VII	34 (85.00)	II
High rodent attack	36 (90.00)	II	26 (65.00)	V	15 (37.50)	IV
Higher insect pest incidence at tillering stage	23 (57.50)	V	30 (75.00)	III	10 (25.00)	VI
Lodging of wheat crop	18 (45.00)	VI	27 (67.50)	IV	14 (35.00)	V

Note: Figures shown in parenthesis indicate per cent to the total

retention of straw in the field with happy seeder/super seeder technology may provide food and shelter for rodents, resulting in their higher infestation and damage in crops (Singla, 2011). Furthermore, poor seed germination was also reported as another problem in adoption of super seeder and happy seeder technology. The problem was ranked in third place by the respondents in super seeder technology (75.00%) and fifth in happy seeder (75.00%) among all constraints. While only 20.00 per cent of respondents adopting MB plough pointed out the same problem. This might be due to the heavy straw load of long duration rice varieties and uneven spread of loose straw due to neglect use of SMS fitted combine harvesters (Singh *et al,* 2020). Yellowing of wheat crop was reported as a constraint by more than 60.00 per cent of respondents adopting these in-situ straw management technologies. It might be due to high C:N ratio of paddy straw leading to its slow decomposition and immobilization of soil nitrates, reducing the N uptake and it results in nitrogen deficiency among the plants (Thuy *et al,* 2008; Bacon, 1987). Higher number of respondents reported the problem of insect pest incidence at the tillering stage in super seeder (75.00%) and happy seeder technology (57.50%) in comparison to the MB plough users (25.00%). During field visit, it was observed that infestation of pink stem borer (*Sesamia inferens*) and army worm (*Mythimna separata*) was found in some of the farmers' fields.

Lodging of wheat crop was felt as a problem by 67.50, 45.00 and 35.00 per cent respondents in adoption of super seeder, happy seeder and MB plough technologies for straw management, respectively. The causes of lodging might be due to unpleasant weather conditions, use of higher doses of nitrogen fertilizer than recommended and heavy irrigation (Mondal, 2020). Problem of weed infestation in wheat crop was faced by 85.00 and 52.50 per cent adopters of MB plough and super seeder technology respectively, however, only few farmers practicing happy seeder technology reported such problem. It might be due to the residue retention at the field in happy seeder technology due to which weed infestation decreases. The fact of a lesser weed population in happy seeder technology has been established in the number of field studies (Yang *et al,* 2018) whereas conventional tillage may provide good seedbed for weed germination (Bahadur *et al,* 2015).

Financial Constraints

Financial constraints restrict a course of economic action, which must be accommodated instead. Under this broad heading, seven constraints were listed. It is clearly evident from Table 2 that high initial investment cost ranked first among all financial constraints in super seeder (82.50%) whereas 42.50 per cent of each respondents adopting MB plough technology and happy seeder technology reported the same problem. As 33 per cent of farmers of state are marginal and small, the high cost of these machines make it difficult to purchase them. Some of these technologies have the requirement of high horsepower tractors. Thus, it is evident that high initial investment cost is an impediment in owning of farm machines by farmers having less operational land holding. Problem of high custom hiring charges were felt by 62.50, 57.50 and 47.50 per cent respondents in the adoption of MB plough, super seeder and happy seeder

Table 2. Financial constraints faced by the farmers in the adoption of different paddy straw management technologies (n=120)

Particulars	Happy Seeder (n_1=40)		Super Seeder (n_2=40)		MB Plough (n_3=40)	
	f	Rank	f	Rank	F	Rank
High initial investment on machines	21 (52.50)	I	33 (82.50)	I	21 (52.50)	IV
High custom hiring charges	19 (47.50)	II	23 (57.50)	IV	25 (62.50)	II
Increase in labour expenditure	15 (37.50)	III	11 (27.50)	VII	7 (17.50)	VI
Costly maintenance of machines	14 (35.00)	V	18 (45.00)	VI	5 (12.50)	VII
Difficulty in getting subsidy on machines	11 (27.50)	VI	31 (77.50)	III	17 (42.50)	V
Insufficient subsidy on machines	15 (37.50)	III	32 (80.00)	II	23 (57.50)	III
Sowing cost increases	5 (12.50)	VII	19 (47.50)	V	36 (90.00)	I

Note: Figures shown in parenthesis indicate per cent to the total

technologies and it ranked second, fourth and second among all the constraints in the aforementioned straw management technologies. Increase in sowing cost was pointed out by majority of the farmers (90.00%) in MB plough technology and it ranked as first among all constraint whereas 47.50 and 12.50 per cent respondents adopting super seeder and happy seeder, respectively, gave their concerns about the same problem. The increase in the cost of sowing in MB plough technology can be attributed to high diesel consumption on cultivating field with MB plough and thereafter use of other conventional implements (disc harrow, cultivator, planker). Furthermore, the majority of the respondents felt insufficient subsidy on machines as another constraint in the adoption of super seeder technology and get second ranked among all constraints. While 57.50 and 37.50 per cent of the respondents adopting MB plough and happy seeder reported the same problem and it get third rank among all the constraints in both technologies. About 77.50 per cent of the respondents

Table 3. General constraints faced by the farmers in the adoption of different paddy straw management technologies (n=120)

Particulars	Happy Seeder (n_1=40)		Super Seeder (n_2=40)		MB Plough (n_3=40)	
	f	Rank	f	Rank	F	Rank
Short time window for wheat sowing after harvesting of paddy crop	27 (67.50)	IV	30 (75.00)	V	38 (95.00)	I
Untimely rain at sowing of wheat crop	37 (92.50)	II	31 (77.50)	IV	25 (62.50)	III
Lower yield of wheat crop in the initial years	39 (97.50)	I	34 (85.00)	II	11 (27.50)	V
Non-availability of machines at peak time	15 (37.50)	V	37 (92.50)	I	13 (32.50)	IV
Poor quality machines	5 (12.50)	VI	9 (22.50)	VI	2 (5.00)	VI
Requirement of high horse power tractors	35 (87.50)	III	33 (82.50)	III	30 (75.00)	II

Note: Figures shown in parenthesis indicate per cent to the total adopting super seeder technology perceived the problem in availing subsidy on purchase of super seeder machine. Technology of super seeder is relatively new and there is high demand and popularity among the farmers. Increase in labour expenditure was experienced by 37.50, 27.50 and 17.50 per cent respondents of happy seeder, super seeder and MB plough, respectively. From the discussion with several farmers, it came out that use of manual labour for spreading the paddy straw increases the labour expenditure in case of happy seeder and super seeder technology.

General Constraints

Table 3 illustrates the typical constraints farmers encounter when adopting various in-situ straw management technologies. Short time window for sowing wheat crop after harvesting of paddy crop was pointed out by the majority of respondents of all the in-situ paddy straw management technologies i.e., MB plough (95.00%), super seeder (75.00%) and happy seeder (67.50%). In happy seeder technology, majority of respondents (97.50%) observed the reduction in wheat yield during the initial years of happy seeder adoption in their fields. About 85.00 per cent of respondents of super seeder technology opined this constraint and found as the second notable constraint, however, only 27.50 per cent mentioned the decrease in yield in initial years. Lower yield of wheat crop in the initial years with use of happy seeder and super seeder also reported in other relevant studies (Chaudhary *et al,* 2021; Sidhu *et al,* 2007). Almost 92.50 per cent of respondents faced the unavailability of machines during the peak season as an important problem in the adoption of super seeder technology. Whereas merely 37.50 and 32.50 per cent respondents mentioned it as constraint in the adoption of happy seeder and MB plough technology, respectively. Moreover, the requirement of high horsepower tractors identified as another major constraint in the adoption of these in-situ straw management technologies. Happy seeder, super seeder and MB plough requires 45 or more, 55 or more and 50 or more horsepower tractors, respectively (PAU, 2021). On a broad scale, these straw management technologies appear to necessitate high-horsepower tractors. Adverse weather conditions like untimely rain at sowing ranked as second, third and fourth prominent constraint in the adoption of happy seeder, MB plough and super seeder technology with the response of 92.50, 62.50 and 77.50 per cent of respondents, respectively.

Conclusion and Policy Implications

Paddy straw management is the need of the hour. Farmers are becoming aware of the consequences of straw burning and good number of farmers have adopted different recommended technologies for straw management. However, the constraints faced in the adoption of straw management technologies by the farmers are many-fold. The present study revealed that there are different technological, financial and general constraints in the adoption of in-situ straw management technologies. It is, therefore, necessary to focus on the problems faced by the farmers regarding paddy straw management. Consistent efforts through capacity building programmes should be made by government agencies as well as extension functionaries to generate awareness among farmers to overcome these constraints. Campaigns should be organized for rodents management and farm literature should be distributed among farmers regarding these technologies. Some of the policy options such as use of machine on cooperative basis, incentives to the farmers for adopting paddy straw management technologies, hassle free provision of subsidies on machinery and regular handholding of farmers may be considered for surging the adoption of in-situ straw management technologies in the state.

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