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Adoption of Agricultural Technology and Socio Economic Impact of Super Straw Management System in Haryana, India

Jatesh Kathpalia [a*], Subhash Chander [a], Rashmi Tyagi [a], Vinod Kumari [a] and Er. Naresh [b]

[a] Department of Sociology, CCSHAU, Hisar, Haryana, India.
[b] Department of FMPE, CCSHAU, Hisar, Haryana, India.

Authors' contributions

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

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ABSTRACT

Super straw management system is a machine in which an additional equipment attached with combine harvester so it cut standing stubble in small pieces on the soil surface in which crop harvesting and residue management both can be done in a single operation. A research involving 120 farmers who were adopters (60 adopters) and non adopters (60 non adopters) of the Super straw Management system was conducted in rural areas of the Fatehabad district of the Indian state of Haryana in 2021–2022. This paper's main goal is to investigate Super Straw Management System adoption as a viable, innovative solution to rice residue burning in rice-wheat cropping systems, as well as the socioeconomic effects of adoption on farmer's livelihoods. The reasons for not implementing the super straw management system were also evaluated. According to the

**Corresponding author: E-mail: kathpaliajatesh@gmail.com;*

findings, medium adoption of SMS was discovered among farmers (41.67%), followed by low adoption among farmers (38.33%) and high adoption among just 20% of the farmers. Factors like age, size of land holding, size of family, annual income, participation in social organisations, media exposure, and socioeconomic status were found significantly associated with adoption of SMS among farmers. While caste, level of education, the family's secondary occupation, and the type of family were not found to be significant with farmers' adoption levels, Results about the reasons why the Super Straw Management System was not adopted clearly demonstrated that there is no alternative for ex-situ straw management while using SMS (rank I). At the same time, farmers (rank II) did not show a readiness to pay additional custom charges. More than 3/5 of the respondents agreed that conventional combines are easily available for hiring (rank III); combine harvesters with SMS used more fuel (3 to 3.25 l/ha) and required higher engine power (8–10 hp) than conventional combine harvesters. Cumulative socio-economic impact of SMS was reported increased with respect to increase in decision making powers which is ranked Ist, followed by increased in extension contacts (IInd rank) and change in attitude for quality education of children (IIIrd rank).

Keywords: Super straw management system; adoption; factors; non-adoption; socio economic impact.

1. INTRODUCTION

Asia's southern and eastern regions are where most rice is produced. The primary producers of rice from this region are China, India, Indonesia, Bangladesh, and Vietnam. That is why this region is the main focus of the study problem related to rice straw and its management [1]. Since rice is the second-largest cereal crop after wheat, a biomass made of rice straw is produced annually in excess of 580580 million tonnes [2], (Reddy & Yang 2006). Paddy agriculture covers 43.95 million hectares in India, and over the past few years, it has produced roughly 106.54 million tonnes of rice and 160 million tonnes of straw. The rice grain to straw production ratio is 1:1.5. Punjab, a little state in northern India, produced roughly 11.27 million tonnes of rice (or 10.6% of the nation's total production) and 16.90 million tonnes of rice straw in 2013–14 [3,4].

Rice straw management can be divided into two categories: in-field methods off-field options. Direct open-field burning of rice straw and incorporating rice straw into paddy soil are two more strategies for managing rice straw that can be used in- field. A further division of the off-field possibilities is made into three major groups: agriculture/dairy, energy generation, and manufacturing. Rice straw is used in the agriculture and dairy industries as compost, bedding material, and for growing mushrooms. Rice straw burning in open fields pollutes the air, water, and land, which is a major issue for the environment [5]. Furthermore, it raises ozone levels and contributes to climate change. Due to a labour scarcity and the necessity to immediately prepare their fields for the growing of the next crop, farmers in the Indian states of Punjab and Haryana practise mechanised agriculture [6]. Open-field crop residue burning releases extremely damaging chemicals into the atmosphere, including hydrocarbon and particulate matter, such as SO2, NO2, CH4, N2O, and carbon monoxide [7]. The burning of rice straw produces a significant amount of CO2 gas, which increases to the global greenhouse effect, it has a very negative impact on the environment. Additionally, it has an impact on the respiratory system of the people who live there [8]. Harvesters leave behind paddy residue that takes 1.5 months to break down, leaving farmers little time to plant their next crop, wheat. Burning the straw is a quick, affordable, and effective approach to get the soil ready for wheat, the next crop. (Chandra et al. 2017), [4]. Crop residue is believed to contain roughly 6 million tonnes of carbon, and when it burns in an open field, it releases 22 million tonnes of carbon dioxide over the course of 15 to 20 days [9]. The pollution caused by burning stubble in Northern Indian areas including Punjab, Haryana, Delhi, and Uttar Pradesh was seriously noted by the Indian Supreme Court [10]. Super Straw Management System (SMS) attachments for their self-propelled combine harvesters have been introduced in an effort to reduce the threat of stubble burning during the post-harvesting season. The leftover rice straw is broken up into small pieces and scattered around the fields using the Super Straw Management System (SMS). Farmers receive some financial assistance from the use of rice straw. Various uses for rice straw as a fuel that could cut greenhouse and other harmful gases are possible. The environment can be protected from

the major pollution scenario of the future in this way. So keeping in view the benefits and need of the super straw management system, a study was designed to know the adoption practices among farmers with following objectives.

1.1 Objectives

1) To study the adoption level of super straw management system among the farmers
2) To delineate the factors affecting the adoption of super straw management system.
3) To examine the socio- economic impact on farmers.
4) To find out the reasons for non-adoption

2. MATERIALS AND METHODS

The study was carried out in Fatehabad district located at Latitude- 29.5 and Longitude -75.4 Of Haryana state as maximum number of farmers had adopted this technology. Four blocks namely Fatehabad, Ratia, Bhattu Kalan and Bhuna were selected where maximum number of farmers had adopted Super Straw Management System. Sixty Super Straw Management System adopter farmers and sixty non-adopter farmers were selected. Level of adoption of SMS by the farmers was measured by developing an index and scores of each farmer was calculated by taking into account four parameters like, I) Land holding(up to 1 ha –score 1,1-2 ha- score 2,2-4 ha score 3 and 4- 10 ha score 4)II) income (Rs.200000 - 300000/- score 1, Rs.300000 - 4,00,000/- score 2 and above Rs. 4,00,000/- score 3),III) years of adoption (upto 2 years score 1and more than 2 years score 2) IV) area under technology (upto 2 ha score 1,2-4 ha score 2 and 4 to 10 ha score 3). The total index score of each farmer was computed and categorised as low level adoption, medium level adoption and high level of adoption Items were also framed to know the reasons for non adoption of SMS from non adopter farmers. On the whole 120 farmers were selected as respondents for the study. Statistical analysis like percentage, frequency, weighted mean score , rank order ,chi square etc. were applied The chi-square formula used was $\chi^2 = \sum(O_i - E_i)^2/E_i$ where O_i = observed value (actual value) and E_i = expected value.

3. RESULTS AND DISCUSSION

3.1 Adoption Level of the Farmers

Adoption level has been given in Table 1. Data revealed adoption level of Super Straw Management system among farmers which is medium among 41.67 per cent followed by low among 38.33 per cent farmers and high adoption level among only 20 per cent farmers. Kathpalia et al. [11] found in a study conducted in Haryana that that 2/5th of the farmers (40.00%) had low level of adoption while 33.33% had medium and rest (26.67%) of the farmers had high level of the adoption.

Table 1. Adoption level of farmers regarding SMS (n=60)

Adoption level	Frequency	Percentage
Low (4-6)	23	38.33
Medium (7-9)	25	41.67
High (10-12)	12	20.00

Figures in parentheses indicate percentage

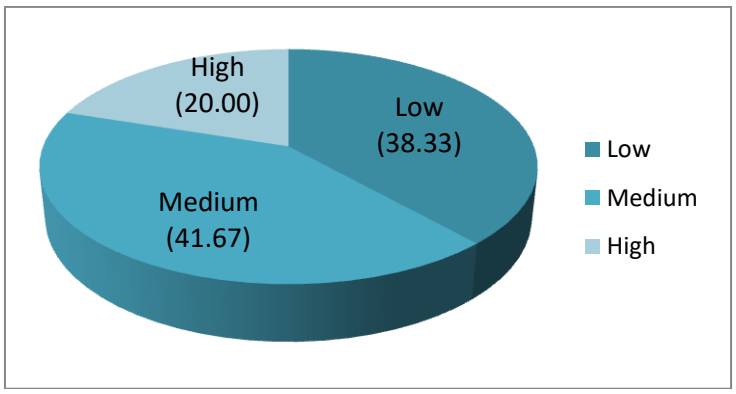

Fig. 1. Adoption level of SMS

3.2 Association between Socio-economic Variables and Adoption Level of Super Straw Management System

Regarding the factors associated with adoption level of SMS as shown in Table 2 revealed that high level of adoption (27.77%) was found among the farmers who were above 50 years and lowest level of adoption (75.00%) was found among the farmers who were up to 35 years of age. Backward class was found with higher level of adoption i.e. 33.33 per cent as comparative to general caste where only 18.52 per cent of the farmers had high level of adoption.

Caste, level of education, subsidiary occupation of the family and type of family was not found significant with adoption level of farmers. Whereas factors such as age, size of land holding, size of family, annual income, social participation, mass-media exposure and socio economic status were found simply significant with adoption level of farmers.

Farmers with medium size of land holdings were found with the highest level of adoption i.e. 44.44 per cent. Whereas 60.00 per cent of the farmers who were having income between Rs.200000/- – 3,00,000/- had the low level of adoption. With regard to social organization participation 65.00 per cent of the farmers who were having participation in one organization were having medium level of adoption. Farmers with higher mass media exposure were having highest adoption level (50.00 per cent) whereas lowest adoption level was found with 62.50 per cent farmers who were having low socio-economic status. Kathpalia et al. [11] also found in a study conducted in Haryana that Super straw management adoption was low among marginal and small landowners but it was strong among moderate sized land owners (50%). Annual income of the farmers, social participation and socioeconomic positions were all found to had a substantial relationship.

Reasons for Non-adoption of SMS: Results from the Table 3 evidently shows that with the use of SMS there is no option for ex-situ straw management (rank I). At the same time farmers did not show willingness to pay extra hiring charges (rank II). More than 3/5th of the respondents agreed that Conventional combines are easily available for hiring (rank III); more (3 to3.25 l/ha) fuel consumption of combine harvester with SMS (rank 1V) and high power engine requirement (8-10 hp) as compared to conventional combine harvester got rank IV with Mean score 2.36.

Table 2. Association between socio-economic variables and Adoption level of farmers (n=60)

Socio-economic variables	**Adoption level**			
Age	**Low**	**Medium**	**High**	**Total**
up to 35 yrs.	9 (75.00)	1 (8.33)	2 (16.67)	12 (20.00)
35^{+} to 50 yrs.	11(36.67)	14 (46.67)	5 (16.66)	30(50.00)
above 50 yrs.	3(16.67)	10(55.56)	5(27.77)	18(30.00)
Total	**23(38.33)**	**25(41.67)**	**12 (20.00)**	**60(100.00)**
χ^2 *Cal*=11.42*				
Caste				
General caste	20(37.04)	24(44.44)	10(18.52)	54 (90.00)
Backward class	3(50.00)	1(16.67)	2(33.33)	6 (10.00)
χ^2 *Cal*=1.82				
Level of Education				
No formal schooling	6(60.00)	3(30.00)	1(10.00)	10 (16.67)
Up to Middle	10(38.46)	14(53.85)	2(7.69)	26(43.33)
Senior Secondary and above senior secondary level	7(29.17)	8(33.33)	9(37.50)	24(40.00)
χ^2 *Cal*=9.54				
Subsidiary occupation of the family				
Nil	17(44.74)	16 (42.10)	5(13.16)	38 (63.33)
Business and services	3(30.00)	5(50.00)	2(20.00)	10(16.67)
Custom hiring	3 (33.33)	4(25.00)	5(41.670	12 (20.00)
χ^2 *Cal*=5.21				
Size of land holdings				
Marginal (up to 1 ha)	6(50.00)	5(41.67)	1(8.33)	12 (20.00)
Small (1-2 ha)	12(52.17)	10(43.48)	1(4.35)	23(38.33)

Socio-economic variables	Adoption level			
Semi-medium (2-4 ha)	4(25.00)	6(37.50)	6(37.50)	16(26.67)
Medium (4-10 ha)	1(11.12)	4(44.44)	4(44.44)	9(15.00)
χ^2 *Cal*=12.93*				
Type of family				
Nuclear	14(45.16)	12(38.71)	5(16.12)	31 (51.67)
Joint	9(31.03)	13(44.83)	7(24.14)	29 (48.33)
χ^2 *Cal*=1.39				
Size of family				
Up to 4 members	9 (45.00)	9(45.00)	2 (10.00)	20 (33.33)
5-8 members	11(45.83)	10(41.67)	3(12.50)	24(40.00)
Above 8 members	3 (18.75)	6(37.50)	7(43.75)	16(26.67)
χ^2 *Cal*=8.49*				
Annual Income(Rs.)				
Rs.2,00000 – 3,00000	6(60.00)	3(30.00)	1(10.00)	10(16.67)
Rs.3,00000 - 4,00000	9(40.90)	12(54.55)	1(4.55)	22(36.66)
Above Rs. 4,00000/-	8(28.58)	10(35.71)	10(35.71)	28(46.67)
χ^2 *Cal*=9.98*				
Social organization participation				
No organization participation	18(52.94)	`10(29.41)	6(17.65)	34 (56.67)
One organization participation	4(20.00)	13(65.00)	3(15.00)	20(33.33)
More than one organization participation	1(16.67)	2(33.33)	3(50.00)	06(10.00)
χ^2 *Cal*=11.36*				
Mass media exposure				
Low (4 to 6)	11(47.83)	8(34.78)	4(14.39)	23 (38.33)
Medium (07-09)	11(44.00)	12(48.00)	2(8.00)	25(41.67)
High (10-12)	1(8.33)	5(41.67)	6(50.00)	12(20.00)
χ^2 *Cal*=11.34*				
Socio-economic Status				
Low(5-8)	10(62.50)	5(31.25)	1(6.25)	16(26.67)
Medium (9-12)	10(37.04)	13(48.15)	4(14.81)	27(45.00)
High (13-16)	3(17.64)	7(41.18)	7(41.18)	17(28.33)
χ^2 *Cal*=10.72*				

Figures in parentheses indicate percentage

Table 3. Reasons for non-adoption of SMS (n=60)

Statements	Reasons for Non-adoption			TMS	WMS	Rank
	Agreed(3)	Neutral (2)	Disagree(1)			
With the use of SMS farmers have no option for ex-situ straw management (like adoption of Baler)	53	7	-	173	2.88	I
Farmers are not ready to pay extra hiring charges for operating combine harvester with SMS	43	10	7	156	2.60	II
Conventional combines without SMS are easily available for hiring	39	11	10	149	2.48	III
More fuel(3to3.25l/ha) consumption of combine harvester with SMS	38	11	11	147	2.45	IV
High power engine requirement (8-10 hp) as compared to conventional combine harvester	35	12	13	142	2.36	V

Cumulative socio economic impact of SMS: Analysis of the study in the Table 4 depicts that cumulative socio-economic impact of SMS had been increased with respect to increase in decision making powers which is ranked Ist, followed by increased in extension contacts (IInd rank) and change in attitude for quality education of children (IIIrd rank) . Whereas increase in household assets/facilities (ranked VIIth) has no change with respect to cumulative socio-economic impact of SMS followed by socio-economic status and social mobility which stands on VIIIth rank and IX rank respectively.

Table 4. Cumulative socio-economic impact of super straw management system (n=60)

Socio - economic impact	Increased (3)	Somewhat Increased(2)	No change(1)	TMS Score	WMS	Rank
Decision making powers	22(36.66)	31(51.67)	07(11.67)	135	2.25	I
Extension contacts	20(33.33)	28(46.67)	12(20.00)	128	2.13	II
Change in attitude for quality education of children	18(30.00)	18(30.00)	24(40.00))	114	1.90	III
Land on lease	10(16.67)	20(33.33)	30(50.00)	100	1.66	IV
Mass media exposure	9(15.00)	21(35.00)	30(50.00)	99	1.65	V
Quality of health services availed	8(13.33)	19(31.67)	33(55.00)	95	1.58	VI
Increase in household assets/ facilities	6(10.00)	19(31.67)	35(58.33)	91	1.51	VII
socioeconomic status	5(8.33)	18(30.00)	37(61.67)	88	1.46	VIII
social mobility	5(8.30)	17(28.33)	38(63.37)	87	1.45	IX

Figures in parentheses indicate percentage

4. CONCLUSION

The adoption of super straw management system has had a significant impact on farmers. It addresses the issue of stubble burning, while simultaneously improving the socio-economic conditions of the farmers. Cumulative socio-economic impact of SMS had been increased with respect to increase in decision making powers(66.66%), followed by increased in extension contacts (33.33%) and change in attitude for quality education of children (30.00%). The traditional practices of burning residue had adverse effects on soil health, leading to reduce crop yield over time. However now with the use of super straw management system farmers can now convert agricultural residue into valuable resources such as organic manure and animal fodder etc.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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