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Farmer's Participatory Approach for the *In-Situ* Management of Paddy Straw with Happy Seeder and Rotavator

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Abstract – **On Farm Trials were conducted in the district of Jalandhar, Kapurthala, Patiala and Fatehgarh Sahib to accelerate technology of happy seeder and rotavator for sowing of wheat in the combine harvested fields for *in-situ* management of paddy straw during 2008-09. Data recorded on paddy straw yield from the field of selected farmers to know the average straw yield during *kharif* of 2008. It was about 9.9, 9.7, 9.5 and 8.0 t/ha in Fatehgarh Sahib, Patiala, Kapurthala and Jalandhar, respectively. Farmers generally follow the practice of burning of paddy straw for sowing of wheat with conventional tillage and lost with this practice average of 33.48 kgha^{-1} available nitrogen, 7.44 kgha^{-1} available phosphorous and 66.03 kgha^{-1}available potassium. Farmers can add large quantity of nutrients in the soil with the recycling of paddy straw by the adoption of happy seeder and rotavator technology for sowing wheat and it will help to conserve irrigation water, improve the soil productivity. The results of this investigation revealed that farmers can get the same or slightly higher grain yield with the adoption of happy seeder (zero tillage) and rotavator (reduced tillage) as compared to farmer's practice, which are also efficient methods for *in-situ* management of paddy straw and control of weed population. Out of the three methods of planting, happy seeder is one of the most efficient methods to reduce the cost of production and to manage the combine harvested paddy straw and ultimately to improve the soil health and productivity of wheat. Rotavator sown crop had shallow root system due to compaction; more weed population as compared to happy seeder, but had less weed population than farmer's practice. The farmers must adopt the zero tillage technology like happy seeder for sowing wheat in the combine harvested fields for *in-situ* management of paddy straw and also to increase the margin of profit.**

Keywords – **Districts, Farmer's Practice, Happy Seeder, Paddy Straw, Rotavator, Wheat.**

I. INTRODUCTION

The rice-wheat system has been practiced by farmers in Asia for more than 1000 years. It has since expanded and is currently estimated at 23.5 million ha. The rice-wheat system covers 13.5 million ha in South Asia: India (10.0), Pakistan (2.2), Bangladesh (0.8) and Nepal (0.5). It represents 32% of the total rice area and 42% of the total wheat area in these countries. In the Indo-Gangetic Plains (IGP), which stretches across these four countries, rice is usually grown in the wet summer (May/June to September/October) and wheat in the dry winter (November/ December to March/April). Although rice-wheat cropped area in the IGP is irrigated or has assured rainwater in sub-humid regions, the soils and crop management undergo drastic changes during the two cropping seasons. Several yield-reducing and yield limiting factors together with delayed planting of wheat and transplanting of rice; energy, labor, and other input shortages; resistance of the weed and crop residue burning have contributed to the stagnating or declining production, productivity and sustainability of this system. Continuous cropping of rice-wheat system for several decades as well as contrasting edaphic needs of these two crops have resulted in increased pest pressure, nutrient mining, and decline in yields in some areas. In many areas, yields have stagnated at below potential level. The input use efficiency is low. Soil organic matter content has reduced. This can be improved by incorporating crop residue into the soil. But burning of crop residue is common and has increased environmental pollution. Nutrients are being mined and transported long distances and lost permanently for the sub-region. The water table has receded at several places in the region. Also, there is a reduction in biodiversity due to large area coverage by a single cultivar. The rice-wheat system, especially residue burning, intensive tillage and injudicious use of water, has weakened the natural base [1].

In Punjab, huge quantity of rice straw (23.49 million tones @ 90 q/ha, sown on an area 26.10 lakh ha during 2007-08) and wheat straw (24.29 million tones @ 70 q/ha, sown on an area about 34.7 lakh ha during 2007-08) is produced. About 11.8 million tons (Approximately half of the total produced) of rice straw is burnt during 2008-09 because farmers followed the technology of rotavator and also incorporated in the soil but most of the wheat straw (More than 90 %) is used as wheat bhusa to feeding the animals and its small quantity (2.4 million approximately 10 % of the total produced) is burnt in the field. There is no serious issue of burning of wheat straw in our state. But burning of paddy straw is a complete loss of nutrients approximately 59000 tones of nitrogen, 17700 tones of phosphorus and 2.95 lakh tones of potassium. It contains 0.5 per cent nitrogen, 0.15 per cent phosphorous, 2.5 per cent potassium and other micro nutrients, if reincorporated in the soil, could substitute for most 60 per cent of the total nutrient consumed during the *kharif* season. Instead of this, 3.72 lakh tones of nutrients in rice straw and husk are completely or partially lost. In India, estimated the crop residue produced by rice and wheat crops to be 240 Mt, of which one-third is available for recycling. The total residue produced in the system was 126 Mt, of which 42 Mt is available for recycling [2].

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Burning of straw also causes environmental pollution leading to many diseases like cough, eye irritation and respiratory disorders. Burning of straw emits toxic and harmful fumes, which include poisonous carbon monoxide. It increases suspended particulate matter in the air and thereby pollutes our atmosphere and smog on roads causes fatal accidents. Burning also produces CO_2, which creates Green House Effect by producing the 17.23 million tones of CO_2 during the short span of 15-20 numbers of days (1 kg of paddy straw on burning produces about 1.46 kg CO_2. The Green House Effect disturbs the natural climate of the planet. In addition, burning also decreases the efficiency of some herbicides used for controlling weeds in wheat crop.

The available paddy straw can be managed by the adoption of no-tillage technology in order to maintain and improve the soil fertility and achieve a sustainable agriculture in Punjab. The Punjab Agricultural University introduced the zero-tillage technology for sowing of wheat and later on it was recommended for other crops like maize, moong, arhar, soybean, barley, linseed and raya. Wheat can be grown without any preparatory tillage if there is no serious problem of weeds to interfere in sowing. In weed infested fields, weeds can be controlled by spraying half litre of Gramaxone (Paraquat) in 200 litres of water before sowing. Zero tillage has many benefits such as saving in diesel and time, less environmental pollution, saving in water during first irrigation, lower weeds infestation particularly *Phalaris minor*, no yellowing of leaves after first irrigation, improved input use efficiency and less lodging. These factors contribute towards increased productivity with reduced cost of production. Besides this, time saved helps in timely planting of wheat over large areas. Use tractor drawn zero-till drill or strip till drill for sowing of wheat in unprepared fields. It is advised that after three years of continuous sowing of wheat under zero tillage, the field should be ploughed to solve the problem of perennial weeds or rodents, if any. Therefore, the Punjab Agricultural University introduced happy seeder after modifying the Australian machine (Happy seeder) for sowing of wheat in the combine harvested fields for *in situ* management of paddy residue with the considerations: the loose straw should be uniformly distributed in the field before planting; the optimum depth of seeding should be between 3.5 to 5.0 cm; ensure proper seed treatment and proper rodent control of measures should be followed. The burning of paddy straw is a big problem in the rice growing areas, for this problem happy seeder and rotavator technology is best solution. But farmers are not prepared to adopt this technology for *in-situ* management of paddy straw. To accelerate the rotavator and happy seeder technology for *in situ* management of paddy straw with the objectives to accelerate the low cost technology like happy seeder and rotavator for the residue management of paddy.

II. METHODOLOGY

On farm trials 10 in each district were conducted in the district of Jalandhar, Kapurthala, Patiala and Fatehgarh Sahib to accelerate technology of happy seeder and rotavator for sowing of wheat in the combine harvested fields for *in-situ* management of paddy straw during 2008-09. In the *Kharif* season of 2008, data was recorded on grain and straw yield of rice from the selected farmers before sowing of wheat. Happy seeder and rotavator machines were used for sowing of wheat in combine harvested paddy fields without any straw burning or removal of paddy straw. The loose straw was uniformly distributed in the field before sowing wheat with happy seeder. In case of sowing with rotavator, the one time it was used in the combine harvested paddy fields to incorporate the paddy straw and second time it was used to mix the broadcasted seed of wheat in the soil. The inputs like one quintal urea and herbicide (Total 75 WP at 40 g/ha) were supplied as an incentive to the selected farmers. The performance of wheat sown with happy seeder and rotavator was compared with farmer's practice followed for sowing of wheat. The observations such as quantity of fertilizer used, weed count per sq. meter, number of days to spray herbicide, plant height, days taken to first irrigation, total number of irrigation applied, ear length, tillers per plant, tillers per meter square, grain and straw yield were recorded from the demonstration fields to compare the performance of wheat sown with happy seeder, rotavator and farmer's practice.

Table 1: Rice grain and straw yield of selected farmers of Kapurthala, Jalandhar, Fatehgarh Sahib and Patiala during Kharif 2008

Kapurthala			Jalandhar			Fatehgarh Sahib			Patiala		
Name of farmer and village	**Rice Yield (t/ha)**	**Rice Straw (tha^{-1})**	**Name of farmer and village**	**Rice Yield (t/ha)**	**Rice Straw (t/ha)**	**Name of farmer and village**	**Rice Yield (t/ha)**	**Rice Straw (t/ha)**	**Name of farmer and village**	**Rice Yield (t/ha)**	**Rice Straw (t/ha)**
Amarjit Singh Fattu chak	6.5	9.8	Mehanga Singh Baupur	6.5	9.8	Amrinder Singh Sangatpur Sodhian	8.23	10.5	Sukhdev Singh Swai Singh wala	6.8	10.1
Bhupinder Singh Majuri Bakkar	6.0	9.0	Jagjit Singh Baupur	7.0	10.5	Sucha Singh Meerpur Sodhian	8.5	10.7	Gurmeet Singh SwaiSinghwala	6.0	9.0
Sukhdev Singh Bhullar Chak	6.0	9.0	Rabinder Singh Baupur	6.3	9.4	Gurnaib Singh Mullanpur	7.5	10.0	Mohinder Singh Swai Singh wala	7.1	10.7

Palvinder Singh Fattu chak	6.3	9.4	Sukhwinder Singh,, Adhi	6.8	10.1	Sukhwinder Singh Meerpur	8.3	10.5	Jagir Singh Meerapur	6.0	9.0
Paramjit Singh Hothiyan	7.0	10.5	Jaidev Bhalla, Nakodar	5.5	8.3	Palwinder Singh Baraunsa Jer	8.8	11.0	Jeet Singh Meerapur	6.4	9.6
Kuldeep Singh Kheerawali	6.5	9.8	Gurbinder Singh Bajwa Uppal Khalsa	3.7	5.6	Harminder Singh Meerpur	8.3	10.5	Pavitar Singh Meerapur	5.6	8.4
Randhir Singh Rahimpur	7.0	10.5	Harbans Singh Uppal Khalsa	4.5	6.8	Satwinder Singh Harpalpur	7.8	10.2	Kuldeep Singh Swai Singh wala	7.1	10.7
Bachan Singh Rahimpur	5.5	8.3	Surinderpal Singh Boparai, Uppal Khalsa	3.8	5.6	Surinderpal Singh Badauchi Kalan	7.5	10.0	Malkiat Singh Swai Singh wala	6.1	9.2
Balbir Singh Rahimpur	6.5	9.8	Sarbjit Singh, Uggi	5.5	8.3	Rajinder Singh Randhawa Bhambri	6.5	8.0	Paritam Singh Swai Singh wala	6.6	9.9
Bakshish Singh Jallowal	6.3	9.4	Jhalman Singh Uppal Khalsa	4.0	6.0	KVK Farm Fategarh Sahib	6.0	7.5	Surinder Singh Swai Singh wala	6.9	10.3
Mean	**6.4**	**9.5**	**Mean**	**5.4**	**8.0**	**Mean**	**7.7**	**9.9**	**Mean**	**6.5**	**9.7**

Table 2: Effect of different treatments on straw yield, emission of CO_2, organic carbon and nutrient present in the straw

Location	Grain yield (t/ha)	Straw yield (t/ha)	Emission of CO_2 (t/ha)	Nutrient present in the straw		
				Nitrogen (kg/ha)	Phosphorous (kg/ha)	Potassium (kg/ha)
Kapurthala	6.35	9.5	13.3	34.20	7.60	67.45
Jalandhar	5.35	8.0	11.2	28.80	6.40	56.80
Fatehgarh Sahib	7.73	9.9	13.9	35.64	7.92	70.29
Patiala	6.46	9.7	13.6	34.92	7.76	68.87
Mean	6.47	9.3	13.0	33.48	7.44	66.03

Paddy straw contains 0.36 % Nitrogen, 0.08% Phosphorous, 0.71%Potassium (*Source*: Handbook of Agriculture ICAR)

III. Results and Discussion

A. Grain and straw yield of rice

Data recorded on rice grain and straw yield are presented in the table 1 & 2. It shows that an average of grain yield of rice was 7.7, 6.5, 6.4 and 5.4 t/ha and rice straw was 9.9, 9.7, 9.5 and 8.0 t/ha in Fatehgarh Sahib, Patiala, Kapurthala and Jalandhar, respectively.

Farmers generally follow the practice of burning of paddy straw for sowing of wheat with conventional tillage. They lost on burning of paddy straw, average 3348 kg/ha available nitrogen, 744 kg/ha available phosphorous and 6603 kg/ha available potassium. Farmers can save large quantity of nutrients with the adoption of zero tillage/ reduce tillage technologies like happy seeder and rotavator and this will help to conserve irrigation water, improve the soil health and its productivity. The long term use of this technology reduces the fertilizer requirement and save the environment from pollution by reducing the emission of CO_2 with an average 13.0 t/ha (Table 2).

B. Number of days taken to apply herbicide

Data on number of days taken to apply herbicide for the control of weeds in crop sown with happy seeder, rotavator and farmer's practice were recorded (Data not given). Farmers took number of days to apply the herbicide for the control of weeds 35-40 days after sowing in Jalandhar and Kapurthala, however, 35-50 and 30-45 days after sowing in Fatehgarh Sahib and Patiala district irrespective of planting techniques, respectively. An average days taken to apply the herbicide 36, 37, 41.7, 43.2 and 39 days after sowing in Jalandhar Kapurthala, Fatehgarh Sahib and Patiala, respectively irrespective of planting techniques. It indicated that farmers of Kapurthlal and Fatehgarh Sahib took more number of days to apply the herbicide than recommended, however, in other districts farmers were applied the herbicide at recommended days (35-40 days after sowing).

C. Weed count in wheat

Data on weed count before the spray of herbicide collected from the happy seeder, rotavator and farmer's practice sown wheat are depicted in the table 3 & 4. The highest average weed count was recorded in farmer's practice (23.9, 50.4, 27.9 and 27.3 m^2) followed by rotavator (14.9, 32.9, 23.9 and 19 m^2) and happy seeder (9.5, 23.7, 18.7 and 15.2 m^2) in Kapurthala, Jalandhar, Fatehgarh Sahib and Patiala, respectively. The lowest weed population in the happy seeder sown crop could be due to the minimum disturbance of soil but higher weed

population in rotavator and farmer's practice sown crop due to favorable conditions by pulverization of soil for germination of weed seeds. It shows that the rotavator and farmer's practice encourage the weed population than the zero tillage technology like happy seeder.

Data on per cent reduction in weed population before the spray of herbicide in the happy seeder over the rotavator and farmer's practice, similarly, rotavator over the farmer's practice sown wheat are presented in the table 3. The per cent reduction in weed population in the happy seeder sown crop over the rotavator and farmer's practice was 36.2, 28.0, 21.8 & 20.0 and 60.3, 53.0, 33.0 & 44.3 and rotavator over the farmer's practice was 37.7, 34.7, 14.3 & 30.4 in the district of Kapurthala, Jalandhar, Fatehgarh Sahib and Patiala, respectively. The average reduction in weed population in the happy seeder sown crop over the rotavator and farmer's practice was 26.5 & 47.7 %, respectively. However, the reduction in weed population in rotavator sown wheat crop was 29.3 % over the farmer's practice.

D. Growth characters of wheat

(a) Plant height

Data on plant height recorded from the happy seeder, rotavator and farmer's practice sown wheat crop in the different districts are presented in the table 6. The plant height varied significantly with methods of planting in Patiala and Jalandhar, but it had non-significant effect on plant height at Fatehgarh Sahib and Kapurthala Plant height of wheat did not vary due to planting methods [3-5]. Similar plant height was also reported in zero tillage and conventional tillage in loamy soil in rice-wheat cropping system [6]. The farmer's practice had significantly lower plant height than happy seeder and rotavator but plant height was similar under happy seeder and rotavator sown crop in Patiala district. However, the differences were non-significant in the plant height recorded in Fatehgarh Sahib and Kapurthala. However, crop sown with rotavator had more plant height in all the districts except Fatehgarh Sahib. The average plant height of the crop sown in the four districts was higher in the rotavator sown crop which might due to the more competition between the plants for sunlight.

Table 3: Per cent increase in weed population in happy seeder sown wheat

Method of planting	Name of District	% reduction in weed population over the rotavator	% reduction in weed population over the Farmer's practice
Happy seeder	Kapurthala	36.2	60.3
	Jalandhar	28.0	53.0
	Fatehgarh Sahib	21.8	33.0
	Patiala	20.0	44.3
Mean		**26.5**	**47.7**
Rotavator			
	Kapurthala	-	37.7
	Jalandhar	-	34.7
	Fatehgarh Sahib	-	14.3
	Patiala	-	30.4
Mean			**29.3**

(b) Number of tillers/plant

Data on tillers per plant are depicted in the table 7. Number of tillers per plant affected significantly with different planting techniques in the four districts. In Patiala, numbers of tillers/plant were recorded higher in the crop sown with happy seeder, which was significantly more than recorded under other methods of planting. However, similar number of tillers per plant was recorded under rotavator and farmer's practice. The similar trend was recorded in the Kapurthala district. The significantly higher numbers of tillers was recorded in the crop sown with happy seeder and were at par in the farmer's practice. However, the lowest was recorded under rotavator as compared to happy seeder and farmer's practice in the district of Fatehgarh Sahib. The highest numbers of tillers/plant were recorded in the crop sown with happy seeder than rotavator and farmer's practice and rotavator sown crops were differed significantly with each other in Jalandhar district. The average numbers of tillers per plant of four locations were higher in the happy seeder sown crop followed by farmer's practice and rotavator. It might due to more competition between the plants of the crop sown with farmer practice and rotavator.

(c) Number of tillers / square meter

Data on number of tillers/square meter are presented in the table 7. Number of tillers/m^2 was affected with different planting techniques in four districts. In Patiala district, significantly more number of tillers/m^2 (416.1) was recorded under rotavator as compared to farmer's practice (396.1) and happy seeder (390.0). Similar trend was recorded in Jalandhar and Kapurthala districts. The significantly higher numbers of tillers were recorded in the crop sown with happy seeder and were at par with rotavator. However, the lowest was recorded under farmer's practice as compared to happy seeder and rotavator in the district of Fatehgarh Sahib. Zero tillage crops had significantly higher number of tillers than other methods of planting [3-5]. The average numbers of tillers per meter square of four locations were higher in the rotavator sown crop followed by farmer's practice and happy seeder. It might due to more population under rotavator and farmer's practice.

E. Yield contributing characters of wheat

(a) Ear length

Data on ear length of wheat of all the districts are presented in the table 6. Ear length had significant variation of wheat sown in the district of Patiala, Kapurthala, Jalandhar except Fatehgarh Sahib. In Patiala, Happy seeder sown crop had significantly more ear length than farmer's practice but it was at par with the crop sown with the rotavator. In Fatehgarh Sahib, crop had the similar ear length under different methods of planting. The differences in ear length were non-significant among the different methods of planting [3-5]. In Kapurthala, ear length of the crop sown with happy seeder was significantly higher than rotavator, which was at par with farmer's practice. In Jalandhar, happy seeder sown crop showed significantly higher ear length as compared to rotavator and farmer's practice, but farmer's practice and rotavator were at par each other in ear length. The

average ear length of the crop sown in four districts was highest in happy seeder followed by rotavator and farmer's practice sown crop.

(b) 1000-grain weight

Data of 1000 - grain weight of wheat presented in the table 8. The 1000-grain weight was not influenced significantly by the planting methods at the different locations. However, the average 1000-grain weight of Happy seeder sown wheat (43.5 g) was slightly higher than rotavator (43.3 g) and farmer's practice sown wheat (43.2 g). No-tillage increased test weights while reducing tillage operations significantly reduced the number of spikelets per head, but increased the 100-seed weight [7].

F. Grain and straw yield of wheat

The grain yield of a crop is the net resultant of methods of planting nitrogen of various factors and is a valid criterion for comparing the efficiency of different treatments. Data on grain yield of wheat sown by happy seeder, rotavator and farmer's practice are presented in table 5. Grain yield in Patiala and Fategarh Sahib differed significantly by sowing of wheat with happy seeder, rotavator and farmer's practice. In Patiala, wheat sown with happy seeder and rotavator gave significantly equivalent grain yield, but significantly higher as compared to farmers practice. An average 9-15 % higher grain yield of wheat was recorded with the happy seeder sowing in rice residues [6], with fertilizer broadcast at sowing and before the first irrigation compared with farmer's practice (conventional tillage after burning. Higher wheat yield was also obtained under zero tillage over the conventional tillage [9]. **A**verage grain yields with no-tillage and conservation tillage were significantly greater than yields using conventional tillage [7]. No tillage increased test weights while reducing tillage operations significantly reduced the number of spikelets per head, but increased the 100-seed weight. However, in Fatehgarh Sahib, significantly equivalent grain yield of wheat was recorded sown with happy seeder and farmer's practice. Zero tillage sowing gave significantly higher grain yield than happy seeder, rotavator and conventional tillage and other three methods of planting were at par with each other [3-5]. Whereas, method of planting did not influence significantly on the grain yield of wheat sown in Jalandhar and Kapurthala district. It is interesting to mention here that the average grain yield of four districts of wheat sown with happy seeder was slightly higher than wheat sown with rotavator (0.7 q/ha) and farmer's practice (0.9 q/ha). It might be due to the higher number of tillers per plant and ear length. Secondly, it could be due to the presence of paddy straw on the soil surface resulted in more availability of moisture for longer period during the growing season.

Data on straw yield of wheat are given in the table 5. The different methods of planting affected significantly on straw yield of wheat sown in Patiala and Fatehgarh Sahib. The higher straw yield was recorded from the crop sown with farmer's practice, which was at par with happy seeder and it was significantly lower than rotavator. Straw yield of wheat sown in Fatehgarh Sahib was varied significantly under all the methods of planting. The significantly lower straw yield was recorded from the crop sown with happy seeder and maximum straw yield was recorded from the crop sown with rotavator, which was significantly more than other two methods of planting. The crop sown with different methods in Jalandhar and Kapurthala, the average straw yield was recorded slightly more from the crop sown with rotavator and farmer's practice than happy seeder. This was happened due to less number of tillers (Table 7)

G. Number of days taken to first irrigation

Data on number of days taken to first irrigation were recorded (Data not given). In Jalandhar, Kapurthala and Fatehgarh Sahib District, first irrigation was applied to the crop planted with happy seeder, rotavator and farmer's practice at 35 to 40 days after sowing and an average 35.7 and 35.8-37.5 days after sowing in Jalandhar and Kapurthala, respectively. However, average number of days taken to first irrigation from 34.8 to 39.0 days after sowing in Fatehgarh Sahib. In Patiala, farmers were applied first irrigation from 21 to 35 days after sowing, but an average took 28 days after sowing for first irrigation. Farmers also observed that crop sown with happy seeder take less time to first irrigation than rotavator and farmer practice because flow of water is higher under happy seeder sown crop. In rotavator and conventional tillage crop was observed yellowing after fist irrigation and farmers get confused with yellowing and nitrogen deficiency and use more fertilizer.

H. Number of irrigations

Data on number of irrigation were recorded (Data not given). The number of irrigation from 3-5, 1-3, 4-5 and 3 were applied and an average number of irrigation were applied 3.4, 2.6-2.7, 4.7-5.0 and 3 to the crop of wheat sown in Jalandhar, Kapurthala, Fatehgarh Sahib and Patiala irrespective of methods of planting. It shows that maximum number of irrigations was applied by the farmers of Fatehgarh Sahib and approximately 3 irrigations were applied in other districts irrespective of methods of planting.

I. Use of nitrogen fertilizer

Data on fertilizer use by the farmers in the crop sown with happy seeder, rotavator and farmer's practice are depicted in the table 9. An average use of nitrogen fertilizer, it indicated that all the farmers (90-100 %) used more than recommended nitrogen fertilizer irrespective of the methods of planting. Similarly, farmers of Patiala and Jalandhar were also used more than recommended phosphorus fertilizer. Many studies proved that use of more fertilizer not increased the yield but increase the cost of production, attack of insects and diseases and create the pollution means contaminate the underground water.

IV. CONCLUSION

On the basis of results of this investigation, it can be concluded that farmers can get the same or slightly higher grain yield with the adoption of happy seeder (zero tillage) and rotavator (reduced tillage) as compared to farmer's practice, which are also efficient methods for *in-situ* management of paddy straw and control of weed

population. However, happy seeder can complete the sowing process in one pass; so, it will be economical for sowing the wheat.

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He is serving as Senior Agronomist in the Department of Agronomy, Punjab Agricultural University, Ludhiana. Presently, working on conservation agriculture for developing technology for residue management, mechanical transplanting of rice and reduce the cost production by using the various machinery.

Table 4: Planting, harvesting date and weed count (m^2) of wheat planted with Happy seeder, Rotavator and Farmer's Practice in Kapurthala and Jalandhar district during Rabi 2008-09

Name of farmer and village	Date of planting	Date of Harvesting	Weed count (m^2)			Name of farmer and village	Date of sowing	Date of Harvesting	Weed count (m^2)		
			Happy seeder	Rota-vator	Farmer's practice				Happy seeder	Rota-vator	Farmer's practice
	Kapurthala						Jallandhar				
Amarjit Singh, Fattu chak	01-11-2008	15-04-09	-	06	06	Mehanga Singh, Baupur	15-11-08	20-04-09	12	24	30
Bhupinder Singh, Majuri Bak	01-11-2008	12-04-09	05	10	12	Jagjit Singh, Baupur	11-11-08	16-04-09	08	18	26
Sukhdev Singh, Bhullar Chak	19-11-2008	16-04-09	19	24	33	Rabinder Singh, Baupur	7-11-08	18-04-09	14	26	34
Palvinder Singh' Fattu chak	02-11-2008	24-04-09	-	07	18	Sukhwinder Singh, Adhi	25-11-08	27-04-09	16	24	14
Paramjit Singh, Hothiyan	20-11-2008	22-04-09	22	26	56	Jaidev Bhalla , Nakodar	21-11-08	20-04-09	23	44	50
Kuldeep Singh, Kheerawali	04-11-2008	25-04-09	08	16	26	Gurbinder Singh Bajwa Uppal Khalsa	22-11-08	24-04-09	16	43	73
Randhir Singh, Rahimpur	11-11-2008	14-04-09	08	14	20	Harbans Singh, Uppal Khalsa	22-11-08	22-04-09	19	35	87
Bachan Singh, Rahimpur	17-11-2008	15-04-09	10	14	22	Surinderpal Singh Boparai, Uppal Khalsa	23-11-08	16-04-09	25	40	54
Balbir Singh, Rahimpur	21-11-2008	13-04-09	15	18	26	Sarbjit Singh, Uggi	9-11-08	12-04-09	00	00	00
Bakshish Singh, Jallowal	16-11-2008	26-04-09	14	18	20	Jhalman Singh, Uppal Khalsa	23-11-08	16-04-09	24	45	56
Mean	-	-	9.5	14.9	23.9	Mean	-	-	23.7	32.9	50.4
	Fatehgarh Sahib						Patiala				
Amrinder Singh, Sangatpur Sodhian	13-11-08	10-04-09	24	30	26	Sukhdev Singh, SwaiSinghwala	30-11-08	14-04-09	10	14	22
Sucha Singh, Meerpur Sodhian	13-11-08	18-04-09	22	18	28	Gurmeet Singh, SwaiSinghwala	02-11-08	14-04-09	15	18	26
Gurnaib Singh, Mullanpur	14-11-08	20-04-09	22	18	24	Mohinder Singh,SwaiSingh wala	02-11-08	14-04-09	34	16	14
Sukhwinder Singh, Meerpur	15-11-08	14-04-09	16	22	20	Jagir Singh, Meerapur	04-11-08	16-04-09	22	26	56
Palwinder Singh, Baraunsa Jer	19-11-08	15-04-09	16	24	44	Jeet Singh, Meerapur	05-11-08	16-04-09	08	16	26
Harminder Singh, Meerpur Sodhian	04-11-08	12-04-09	15	20	25	Pavitar Singh, Meerapur	08-11-08	16-04-09	08	14	20
Satwinder Singh, Harpalpur	05-11-08	14-04-09	18	25	30	Kuldeep Singh, Swai Singhwala	11-11-08	15-04-09	16	24	14
Surinderpal Singh Badauchi Kalan	30-11-08	16-04-09	10	22	28	Malkiat Singh, Swai Singhwala	11-11-08	14-04-09	16	24	44
RajinderSingh,Randhawa Bhambri	06-11-08	14-04-09	25	38	30	Paritam Singh, SwaiSinghwala	13-11-08	17-04-09	15	20	25
KVK Farm, Fategarh Sahib	02-11-08	21-04-09	19	22	24	Surinder Singh, SwaiSinghwala	13-11-08	17-04-09	08	18	26
Mean			18.7	23.9	27.9	Mean			15.2	19.0	27.3

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Table 5: Effect of different planting techniques on grain and straw yield of wheat sown in different districts

Treatments	Grain yield (q/ha)					Straw yield (q/ha)				
	Patiala	Fatehgarh Sahib	Kapurthala	Jalandhar	Mean	Patiala	Fatehgarh Sahib	Kapurthala	Jalandhar	Mean
Happy Seeder	42.9	46.2	42.2	42.9	43.6	67.5	52.9	64.5	66.5	62.9
Rotavator	42.9	43.3	41.3	43.9	42.9	72.5	50.4	63.1	68.0	63.5
Farmer's Practice	41.0	45.7	41.9	42.0	42.7	69.6	54.6	64.1	65.1	63.4
CD (p=0.05)	**1.4**	**1.6**	**NS**	**NS**	**-**	**2.9**	**1.2**	**NS**	**NS**	**-**

Table 6: Effect of different planting techniques on ear length and plant height of wheat sown in different districts

Treatments	Ear length (cm)					Plant height (cm)				
	Patiala	Fatehgarh Sahib	Kapurthala	Jalandhar	Mean	Patiala	Fatehgarh Sahib	Kapurthala	Jalandhar	Mean
Happy Seeder	11.4	11.1	10.6	11.2	10.9	77.7	84.7	77.5	78.1	78.7
Rotavator	11.2	10.2	9.8	9.8	10.3	78.0	81.3	78.4	80.0	79.0
Farmer's Practice	9.7	10.5	9.9	10.0	10.2	67.6	85.7	75.3	75.1	77.1
CD (p=0.05)	**0.8**	**NS**	**0.7**	**0.5**	**-**	**3.5**	**NS**	**NS**	**3.3**	**-**

Table 7: Effect of different planting techniques on number of tillers per plant and number of tillers per meter row length of wheat sown in different districts

Treatments	No. of Tillers/plant					No. of Tillers/m^2				
	Patiala	Fatehgarh Sahib	Kapurthala	Jalandhar	Mean	Patiala	Fatehgarh Sahib	Kapurthala	Jalandhar	Mean
Happy Seeder	3.3	5.7	8.8	9.2	6.7	390.0	493.1	535.0	499.2	479.3
Rotavator	3.0	4.3	7.2	6.7	5.3	416.1	488.3	550.0	505.0	489.9
Farmer Practice	3.1	5.0	7.0	8.0	5.8	396.1	477.5	545.0	500.8	479.9
CD (p=0.05)	**0.1**	**0.8**	**1.0**	**0.7**	**-**	**10.1**	**9.0**	**10.2**	**NS**	**-**

Table 8: Effect of different planting techniques on 1000-grain weight of wheat sown in different districts

Treatments	1000-grain weight				
	Patiala	Fatehgarh Sahib	Kapurthala	Jalandhar	Mean
Happy Seeder	44.5	43.7	43.4	42.5	43.5
Rotavator	43.9	43.4	42.8	43.0	43.3
Farmer's Practice	42.5	42.7	44.0	43.4	43.2
CD (p=0.05)	**NS**	**NS**	**NS**	**NS**	**-**

Table 9: Quantity of fertilizers (Kg/ha) used by different farmers of Kapurthala, Jalandhar, Fatehgarh Sahib and Patiala districts

Name of farmer and village	Happy Seeder		Rotavator		Farmer's practice		Name of farmer and village	Happy Seeder		Rotavator		Farmer's practice	
	Urea	DAP	Urea	DAP	Urea	DAP		Urea	DAP	Urea	DAP	Urea	DAP
	Kapurthala							Jalandhar					
Amarjit Singh, Fattu chak	250.0	125.0	250.0	125.0	250.0	125.0	Mehanga Singh, Baupur	250.0	187.5	250.0	187.5	250.0	
Bhupinder Singh, Majuri Bakkar	275.0	125.0	275.0	125.0	275.0	125.0	Jagjit Singh, Baupur	250.0	125.0	250.0	125.0	250.0	125.0
Sukhdev Singh, Bhullar Chak	250.0	125.0	250.0	125.0	250.0	125.0	Rabinder Singh, Baupur	250.0	187.5	250.0	187.5	250.0	187.5
Palvinder Singh, Fattu chak	250.0	125.0	250.0	125.0	250.0	125.0	Sukhwinder Singh, Adhi	187.5	187.5	187.5	187.5	187.5	187.5
Paramjit Singh, Hothiyan	375.0	125.0	375.0	1375.0	250.0	125.0	Jaidev Bhalla, Nakodar	250.0	125.0	250.0	125.0	250.0	125.0
Kuldeep Singh, Kheerawali	312.5	125.0	312.5	125.0	375.0	125.0	Gurbinder Singh Bajwa Uppal Khalsa	312.5	187.5	312.5	187.5	312.5	187.5
Randhir Singh, Rahimpur	187.5	125.0	187.5	125.0	187.5	125.0	Harbans Singh, Uppal Khalsa	275.0	137.5	275.0	137.5	275	137.5
Bachan Singh, Rahimpur	250.0	125.0	250.0	125.0	250.0	125.0	Surinderpal Singh Boparai, Uppal Khalsa	312.5	187.5	312.5	187.5	312.5	187.5
Balbir Singh, Rahimpur	312.5	187.5	312.5	187.5	312.5	187.5	Sarbjit Singh, Uggi	312.5	187.5	312.5	187.5	312.5	187.5
Bakshish Singh, Jallowal	312.5	125.0	312.5	125.0	312.5	125.0	Jhalman Singh, Uppal Khalsa	275.0	137.5	275.0	137.5	275.0	137.5
Mean	277.5	131.3	277.5	256.3	271.25	131.3	Mean	267.5	165	267.5	165	267.5	165

Fatehgarh Sahib							Patiala						
Amrinder Singh, Sangatpur Sodhian	312.5	125	312.5	125	312.5	125	Sukhdev Singh, Swai Singh wala	375.0	150.0	375.0	150.0	375.0	150.0
Sucha Singh, Meerpur Sodhian	250.0	125	250	125	250	125	Gurmeet Singh SwaiSinghwala	312.5	187.5	312.5	187.5	312.5	187.5
Gurnaib Singh, Mullanpur	250.0	125	250	125	250	125	Mohinder Singh, Swai Singh wala	375.0	187.5	375.0	187.5	375.0	187.5
Sukhwinder Singh, Meerpur	312.5	187.5	312.5	187.5	312.5	187.5	Jagir Singh, Meerapur	500.0	187.5	500.0	187.5	500.0	187.5
Palwinder Singh, Baraunsa Jer	250.0	125	250	125	250	125	Jeet Singh, Meerapur	312.5	187.5	312.5	187.5	312.5	187.5
Harminder Singh, Meerpur	312.5	125	312.5	125	312.5	125	Pavitar Singh, Meerapur	275.0	137.5	275.0	137.5	275.0	137.5
Satwinder Singh, Harpalpur	250.0	125	250	125	250	125	Kuldeep Singh, Swai Singh wala	312.5	187.5	312.5	187.5	312.5	187.5
Surinderpal Singh, Badauchi Kalan	250.0	125	250	125	250	125	Malkiat Singh, Swai Singh wala	275.0	125.0	275.0	125.0	275.0	125.0
Rajinder Singh Randhawa, Bhambri	312.5	187.5	312.5	187.5	312.5	187.5	Paritam Singh, Swai Singh wala	312.5	187.5	312.5	187.5	312.5	187.5
KVK Farm, Fategarh Sahib	225.0	125	225	125	225	125	Surinder Singh,Swai Singh wala	250.0	125.0	250.0	125.0	250.0	125.0
Mean	272.5	137.5	272.5	137.5	272.5	137.5	Mean	330.0	166.3	330.0	166.3	330.0	166.3

Recommended Rate: 225 kg/ha Urea , 137.5 kg/ha DAP