Actual Challenges : Developing a Low Cost No-till Wheat Seeding Technologies for Heavy Residues; The Happy Seeder

H.S. Sidhu[1],Yadvinder Singh[1], Manpreet Singh[1], J. Blackwell[2], Harmanjit Singh[1], Rajinder Pal Singh[3] and H.S. Dhaliwal [1] and Ajaib Singh[1]

[1]Punjab Agricultural University, Ludhiana 141 004, Punjab, India

[2]International Centre of WATER for Food Security, Charles Sturt University, Wagga Wagga, Australia

[3]Department of Primary Industries, NSW, Australia

Rice-wheat (RW) is the most popular cropping system followed on around 13.5 million ha area in the South Asia extending across the Indo-Gangetic alluvial plain. In north-western India combine harvesting of rice and wheat is now a common practice leaving large amount of crop residues in the fields. Rice straw has no economic uses and remains unutilized. To vacate fields for the timely sowing of wheat, majority of the rice straw is burnt in situ by the farmers causing environmental pollution and loss of plant nutrients and organic matter. Recently, Punjab Agricultural University, Ludhiana in collaboration with Australian Centre for International Agricultural Research has developed a new machine called 'Happy Seeder'. The Happy Seeder which needs 45 hp tractor for its working cuts, lifts and manages the standing stubble & loose straw, retaining it as surface mulch and sows wheat in a single operational pass of the field.

It is encouraging to note that about 80 ha area each in India and Pakistan have been successfully sown wheat using Happy Seeder during 2007-08 producing 5-10% more yield (with 50-60% less operational costs) compared to conventional sown wheat. Additional advantages like less weed growth, water saving, improved soil health & environment quality were also noted under the use of 'Happy Seeder' technology. Machine weight, load on the tractor and choking of machine under heavy stubble load were the major constraints in machine operation. Our objective was to develop new prototype of Happy Seeder which will work efficiently with 35hp tractors mostly available with farmers in the region. To achieve the above objective several modifications/improvements in machine design were made and tested under field conditions. These modifications included: increasing row spacing , blade geometry, blade tip speed, machine weight and rotor size/curvature to reduce the power requirement of the present machine. A light weight prototype of Happy Seeder with 30% more tip speed of modified rotor blades, 40% more window opening for easy loose straw movement and 19 % less weight has been developed having row to row spacing 25.7 cm. Replicated field experiments conducted at three locations during 2007-08 showed that row to row spacing of 30 cm out yielded the conventional 20 cm row spacing by 10 %. The detailed field evaluation of the prototype is in progress for analysing the interactive effect of variety, date of sowing and row spacing on wheat yield during 2008-09. A very dedicated and committed extension efforts & government support is required to popularize this eco-friendly technology for sustainable agriculture.

Keywords: Happy Seeder, Rice Residues, Management, Surface Mulching, Direct Drilling

Rice wheat (RW) is the major cropping system in the Indo-Gangetic Plains of South Asia grown on about 13.5 million ha each year (Timsina and Connor 2001). About 2.6 million ha are under RW system in the small state of Punjab, India alone where more than 90% of the area under rice is machine harvested leaving behind enormous quantity of residues. Rice straw is considered (excepting that from basmati variety) as of inferior feeding quality and has very limited alternative uses. Thus the majority of rice straw (about 18 million tons) is burnt in the field in Punjab, India, as this is a rapid and cheap management option, allowing for quick a turn around between crops. In addition to huge loss of plant nutrients (particularly nitrogen and sulphur) and organic matter, burning causes severe air pollution with deleterious effects on human and animal health (Bijay Singh et al. 2007, Dobermann and Fairhurst 2002). Crop residues are a renewable resource for improving soil health and are important for the sustainability of the RW eco system.

In-situ rice straw incorporation has been previously recommended as a an alternate to burning but it is practised by less than 1 % of the farmers only as it is costly and energy & time intensive. Morever, loose residues interfere with tillage and seeding operations for wheat. Developing a cost-effective technology for efficient in-situ management of this vast resource was a challenging task for the farm engineers. Minimum and zero-till technologies for wheat have been demonstrated beneficial in terms of economics, irrigation water saving and timeliness of sowing in comparison with conventional tillage (Malik et al. 2004; Humphreys et al. 2007 ; Singh et al. 2008). However, there are problems with direct drilling of wheat into combine harvested rice fields as loose straw accumulates in the seed drill furrow openers, seed metering drive wheel traction is poor due to the presence of loose straw and the depth of seed placement is non-uniform due to frequent lifting of the implement under heavy trash conditions.

Happy Seeder describes a new approach in solving the problems of direct drilling of wheat into heavy rice residues in a single operational pass while retaining the residues as surface mulch. Happy Seeder consists of a straw managing unit and a sowing unit in one composite machine. The hinged flails mounted on the rotating shaft cuts the standing stubbles and loose straw coming in front of the furrow opener with simultaneous tyne cleaning (for proper seed placement) and places the residue in between the sowing tynes. This PTO operated machine can be operated with 45 hp double clutch tractors and can cover 0.3 – 0.4 ha/hr. The Happy Seeder technology (HST) provided an alternative to burning and thus Govt of Punjab, India is encouraging adoption of this technique. The HST during 2007-08 produced 5-10% more yield (with 50-60% less operational costs) compared to conventional sown wheat. Financial analysis showed that the Happy Seeder is more profitable than the conventional alternatives, full stubble incorporation or direct drilling or rotary seeding both of which require at least partial burning whereas the Happy seeders does not require any burning of the rice residue. The study has also identified important health, community and environmental benefits from the widespread adoption of the Happy Seeder (Singh et al 2008). Additional advantages like 60-70% less weed growth, water saving (particularly pre-sowing irrigation), improved soil health (through improvements in nutrient supply capacity and soil structure) and environment quality improvement were noted for the technology (Sidhu et al 2007).

Loose straw spreading, machine weight, load on the tractor (requiring 45 hp tractor for operation) and choking of machine under heavy stubble load were the major constraints in the early machine operation. The existing machine is more expensive which is a key barrier to adoption for the poorer segment of farmers in North West India. The objective of the present study was to develop a new prototype of Happy Seeder which will work efficiently in heavy straw load with 35hp tractors mostly available with farmers in the region.

Materials and Methods

Machinery Development: Initially the furrow openers and rotor were positioned according to the normal row to row spacing of 20 cm with nine furrow openers in the machine. In 2007-08 row to row spacing was adjusted to 20-40-20 cm and 30-30 cm with the hypothesis that the wider row to row spacing in wheat will compensate for low plant population with high tiller density thereby no adverse effects on yield. In order to achieve the 20-40-20 cm row geometry, alternate furrow openers and rotor blades were removed and there were only six furrow openers along the width of machine. But to achieve the 30-30 cm line spacing geometry the furrow openers and rotor was modified and adjusted in such a way that distance between the two openings was 30 cm and there were only six furrow openers along the width of machine. The power requirement of Happy Seeder was reduced by modifying the rotor and position & shape of blades (C type and Gamma type) as well as furrow openers. Fuel consumption was also monitored for two blade shapes.

Field Experiments: Three replicated field trials were conducted at PAU Ludhiana (loamy sand and sandy loam soils) and KVK, Sangrur (sandy loam), Punjab, India to evaluate the effect of row spacing on the wheat yield during 2007-08. Wheat was sown with Happy Seeder using three row spacings/geometries of 20-20 cm, 20-40-20 cm and 30-30 cm using a seed rate of 100 kg/ha. Fertilizer, weed and irrigation management practices were followed as per recommended package of practice of Punjab Agricultural University, Ludhiana (Anonymous 2008) . At sowing 60 kg/ha P_2O_5 ha^{-1} as DAP was drilled along with the seed and 35 kg N/ha as urea was broadcast before sowing. Additional 60 kg N/ha urea was top dressed 21-25 days after sowing prior to 1st irrigation. Grain yield was recorded at the time of maturity from 6 m^2 area with in the each plot.

Results and Discussion

Wheat sown with a 30-30 cm row spacing yielded 10 % more compared to other row spacings/geometries (Table 1). The increase in grain yield with 30-30 cm spacing compared to the 20-20 cm and 20-40-20 cm spacing was possibly due to increase in the tillering density, grain weight and no. of grains per ear head. Based on the encouraging results from study, a light weight prototype (Figs. 1, 2 & 3) of Happy Seeder with 30% more tip speed of modified rotor blades, 40% more window opening for easy loose straw movement and 19 % less weight has been developed having row to row spacing 25.7 cm (Table 2). It was also observed that the new Gamma type blades consumed 34 % less fuel as compared to the L-type blades.

Table 1. Grain Yield (t/ha) of different row to row spacing experimental trials

Sites	Soil type	Straw Load (t/ha)	Sowing date	Yield (t/ha)		
				Row spacing (20 cm)	Row spacing (20-40-20 cm)	Row spacing (20-40-20 cm)
1	Loamy sand	8.25	28.10.07	4.22±0.12	4.68±0.27	4.93±0.56
2	Sandy loam	8.94	6.11.07	4.89±0.30	4.47±0.24	5.21±0.14
3	Sandy loam	8.30	7.11.07	3.285±0.28	3.47±0.21	3.98±0.30

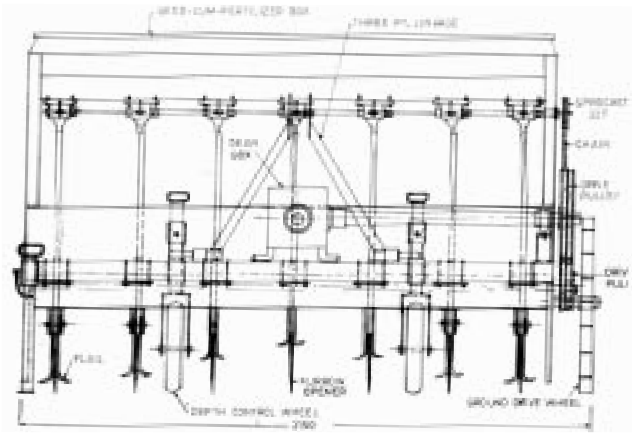

Figure 1. Front view of Happy Seeder

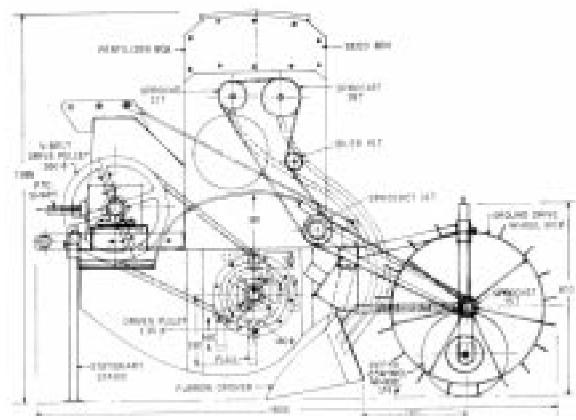

Figure 2. Side view of Happy Seeder

Figure 3. New prototype of Happy Seeder in operation with 35 HP tractor

Table 2. Comparison of modified prototype of HS with the existing machine

Sr. No.	Specifications	Happy Seeder	
		Happy Seeder (45 hp)	New prototype (35 hp)
1	Machine function	Direct drilling of wheat/ mungbean into residues.	Direct drilling of wheat/ mungbean into residues.
2	Horse power required, hp	45	35
3	Flails tip speed (m/sec) at 1000 tractor engine rpm	26.98	35.07
4	Capacity, ha/h	0.26 – 0.3	0.26 – 0.3
5	Window area, m^2	561	786
6	Weight, kg	625	506
7	Fuel Consumption, l/ha	16.22	11.63
8	Rotor drum diameter, mm	290	381
9	Cost, US $	2062	1753

It is encouraging to note that area under Happy Seeder Technology has increased from 80 ha in 2007-08 to 280 ha in 2008-09 in Punjab, India. Approximately 30 machines have been sold to Government departments and Industry by three different manufacturers in the Indian Punjab. Ten field research trials for evaluating the newly developed Happy Seeder (35 hp model, 25.7 cm row to row spacing) are in progress at different locations in Punjab, India during the 2008-09 wheat season. Three replicated trials to study the interaction effect of date of sowing, wheat variety and row to row spacing are also in progress during current wheat sowing season.

Constraints and Challenges

The constraint and challenges related to HST which include uniform spreading of loose rice straw in the combine harvested fields before using the machine, damage of germinating wheat seedlings by rodents and the difficulty of forming bunds in uncultivated fields in the presence of rice residue, are being addressed. A mechanical device attached to the combine harvester has been developed and tested under field conditions for uniform spreading of rice straw in combine harvested fields. Use of the spreader attached with the combine harvester will enable harvesting of rice and sowing of wheat using HST on the same day in the residual soil moisture thus saving the use of precious water for pre-sowing irrigation. A simple and cost effective technology is already in place to control rodents in the wheat fields (Anonymous 2008). Similarly, a tractor-drawn disc bund maker is available to prepare bunds in wheat fields with heavy straw loads. Training of contractors and technical staff is essential for proper operation and maintenance of machine. The involvement of contractors is also important to enable farmers with small holdings to be able to have access to the technology without having to buy the costly Happy Seeder planters (US $ 1753) of their own. A highly dedicated and committed extension effort along with sincere government support are required to popularize this eco-friendly technology for sustainable agriculture on large areas under RW system.

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