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Performance evaluation of turbo happy seeder: A review

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Abstract
A field experiment was conducted on the performance evolution of the happy seeder and compared with the conventional method to know its effectiveness over the sowing technique. The performance evaluation was done from the basis of field capacity, field wheel slippage (%), efficiency, actual field capacity, fuel consumption yield (tones/ha) and cost of operation, the compression of the economics of operation of happy seeder with the conventional method of sowing wheat in the combined harvested paddy field, to prove the effectiveness. The result of the field test conducted showed that the working performance was proper at the operating speed was varying from 2.5 to 3.5 kmph to evaluate the variables. The field efficiency of happy seeder was 43.4% and 65.04% for seed drill at an operating speed of 3.5 kmph. The crop residue is heavy which was collected by sampling. The cost of operating per hectare by happy seeder was Rs. 2098.65 and cost of operation per hectare by seed drill + tillage operations were Rs.3106.38. Therefore, the cost of operational with happy economical as compared to seed drill by Rs.1008.38 per hectare. Nevertheless, the happy seeder is a unique technique for sowing in a combine-harvested paddy field.

Keywords: Happy seeder, rice, wheat, seed drill

1. Introduction

Rice-wheat is a major crop rotation in the Indo-Gangetic region. About 26.5 laces ha area is under this rotation in the state of Punjab alone (Anonymous, 2011). Globally no-tillage and minimum tillage technologies are showing their edge over the conventional practices in terms of economics, water-saving and eco-friendly. In northwestern India combine, the harvesting of rice and wheat is a common practice leaving a large number of crop residues in the fields. The area under combine harvested rice and wheat is about 91% and 82% of the total area under the two crops, respectively. The total quantity of paddy straw produced annually under these crops in the state is about 22 m. While at present more than 80% of wheat the farmers after collect residue combines harvesting using a straw combine.

Rice straw is considered poor feed for animals due to its high silica content and has also no other economic uses and remains unutilized. To vacate fields for the timely sowing of wheat, the majority of the rice straw is burnt in situ by the farmers because residues interfere with tillage and seeding operations for the next crop. Burning rice stubble is a rapid and cheap option for the farmer, which causes serious atmospheric pollution as well as human health. It is estimated that in Punjab alone, about 2.0 lakh tones of N and S in the paddy residues are lost during burning, costing more than Rs. 200 crores at the prevailing prices. One ton of crop residue on burning release, 1,515 kg CO_2, 92 kg Co, 3.83 kg N_2O, 0.4 kg SO_2, 2.7 kg CH_4 and 15.7 kg non-methane volatile organic compounds. The gaseous emissions from the burning of paddy straw analyzed 70% CO_2, 7% CO, 0.66% CH_4 and 2.09% N_2O. The direct drilling of any crop in to combine harvested rice stubbles from a reasonable rice yield has not been possible without prior burning or removal of straw. The rice-wheat farming system is the most dominant and profitable in the Indo-Genetic Plan region of India. Both national and provincial governments through a range of input subsidies (machinery, fertilizer, water, electricity and credit and price support mechanisms (USDA, 2004) have heavily supported Rice wheat rotation.

The majority of the rice in Uttar Pradesh is mechanically harvested, leaving heavy loads of straw and lose straw in windrows. With short time frames between the harvesting of rice and sowing the proceeding wheat crop, farmers have managed high stubble loads through the practice of burning.

At present more than 90 percent of rice, stubble produced annually in India is burnt each year. Burning is less prevalent in other Indian states where yields are lower and rice crops are harvested manually, leaving lighter loads of 2-4 ton/hectare of stubble in the field. Consequently, farmers can cultivate and sow wheat conventionally, or direct drill wheat into the rice residue, without significant difficulty.

The main production system of NW India is an annual rice/wheat rotation. The wheat straw can be used as animal fodder; the management of rice straw is more problematic. The time between the harvesting of rice and sowing of the wheat crop is limited and allowing time for the rice residue to breakdown delays the sowing of wheat beyond the optimum sowing date (15-20 November). This delay results in yield losses of 1% per day delay in sowing. To avoid sowing delays and blockage of cultivation implements by rice residue, Farmer burns rice straw in the field. However, this effects in nutrient loss and reduces in soil microbial populations. Burning also produces dangerous greenhouse gases and particulate emissions, associated with human fitness problems. However, one of the foremost constraints in large scale adoption of this era as well as sub-optimal use performance of the planter is the dearth of skills/ expertise on operation, calibration and upkeep of the machinery. There are distinct field solution specific adjustments wished before the use of the gadget inside the discipline. These changes include proper seeding depth, fertilizer rate and the seed charge, etc. as in keeping with the crop and field conditions to understand the potential benefits of the technology.

One of the key features of CA is balanced soil cover with organics (crop residues, cover crops, etc) has better significance not only in terms of dealing the farming excess but predominantly for removing scorching, educating soil health, save water, help in adaptation to and justifying of weather alteration things. In most, combine harvested rice fields of western IGP, the rice residues are well-done earlier lodging of wheat. Burning linking imperfect burning can also be a cause of net releases of numerous greenhouse gases counting CO, CH_4, SO_2 and N_2O. Crop residue burning accounts for 6.6 million tons of CO_2 equal production yearly in India (INCCA, 2010). Separately after the loss of carbon, up to 80% loss of N and S, 25% of P and 21% of K happens throughout the red-hot of crop remains (Ponnamperuma, 1984; Yadvinder-Singh *et al.,* 2010) [20].

Numerous trials connected with till based conservative production applies that comprise weakening natural incomes, deteriorating issue output, harvest upland, shortages of water & labor and mounting costs of manufacture inputs joined with developing tests of climate change both in watered rigorous schemes as well as low-intensity rainfed ecologies are the major threat to food safety of South Asia (Jat *et al.*, 2009; Ladha *et al.*, 2009; Chauhan *et al*., 2012) [9, 13, 2].

The problematic has additional been deepened with the inaccessibility of labor in time, and a multi-fold surge in labour costs. Disjointed land assets and center farm relations additional worsen the problematic of the availability of farm labour. Potential solutions to address these issues include a shift from concentrated spadework built does to conservation agriculture (CA) founded crop management systems (Saharawat *et al*., 2010; Jat *et al*., 2012; Gathala *et al*., 2013) [16, 12, 4]. Direct drilling (seeding/planting with zero tillage technology) is one such practice that potentially addresses the issues of labor, energy, water, soil health, etc (Malik *et al.*, 2005; Gupta and Sayre, 2007; Jat *et al*., 2009; Ladha *et al*., 2009[13]; Gathala *et al*., 2011[3]; Jat *et al*., 2013) [14, 6, 9, 13, 3, 8] and adaptations to climatic variability (Jat *et al*., 2009; Malik *et al*., 2013) [9, 15].

Numerous types of machinery builders source these pots but the working guides are not accessible for creation changes, standardizations under local situations. In absence of the proper working rules and procedures for effectual use of this machine by the farmers, service providers, extension agents, many a time the desirable results are not achieved and even contradictory results are observed. This results in slow down the adoption rates of the technology. Besides, in the absence of simple guidelines for maintenance of the machine, the farmers/service providers need to make huge investments in repairing at the start of the season. Therefore, we attempted to develop turbo happy seeder and we carried performance evaluation.

2. Materials and Methods

2.1 Turbo happy Seeder Reputation

Conservation Agriculture (CA) based management applies have been reported as a potential strategy to address the labor, water, energy, soil health farm profitability and climate change issues generally encountered under the conventional tillage-based crop production systems. Turbo happy seeder is a planter capable of direct drilling in the fields with surface retention of residues and without any soil disturbance, which in turn takes care of 2 of the 3 basic elements of CA. The direct drilling (zero tillage) operation saves the workforce, power requirement, water, production cost reduces as well as increases the soil health for early plating to get higher productivity (Sidhu *et al*., 2007, 2011) [17, 18]. The reduction of residues lowers the water evaporation, does not alter the soil moisture, and in addition to this it reduces the temperature (Jat *et al.*, 2009; and Gupta *et al.*, 2010; Jat *et al.*, 2011; Alvarez and Steinbach 2009; Jat, 2013) [9, 5, 10, 1, 11]. With the discovery of Turbo Happy Seeder (THS), farmers are need not to burn residues for sowing next crop even with heavy residue loads in excessive yielding plants harvested the usage of combines.

The THS has a facility of direct drilling of seed and fertilizers at anticipated seed and fertilizer rates, depth and spacing in one go. We have added another improvement with additional attachment of seed box having inclined plate seed metering systems, the THS becomes a precise multi-crop planter. This type of arrangement allows the planter for direct drilling of different small and coarse grain crops with the change in inclined plates and gear by the optimal geometry of different crops. Under the scenario of smallholder farm typologies across South Asia, it is neither affordable, not advisable to purchase planter for the planting of different crops by all the farmers.

2.2 Major components and description of turbo happy seeder

The turbo happy seeder has nearly 20 major components as described in Figure.1.

2.3 Calibration of machine for seed and fertilizer rates

2.3.1 Calibration in laboratory

Calibration of THS for seed and fertilizer done to ensure the placement of the right number of seed and Fertilizer in the field. The following method is used to do the calibration:

1. Jack up the machine and check the free Rotation of driving wheel and seed and fertilizer feed-shafts.

2. Place containers or polythene bags under each seed tube.
3. Measure the circumference of the driving wheel (Figure 2.) The circumference gives the distance covered in one revolution of a wheel.
4. Measure the width of the machine by multiplying the number of furrows openers and distance between them.
5. Find the number of revolutions mandatory to plant a one-acre area as follows: Multiply this by 9/10 to take care of wheel skid in the field.

$$\text{Number of revolutions} = \frac{Area\ (acre, sq.m)}{Size\ of\ drill\ (m) \times circumference\ of\ wheel}$$

6. Mark a point on the rim of a wheel. Rotate the wheel by 1/50th of the number of revolutions required to plant one acre as Obtained in step 5. Collect the seed from each pipe and weigh it.
7. For getting seed rate per acre, multiply by 50.
8. Adjust the shift lever on the feed box for grain rate accordingly, i.e. if the seed rate seems to be less than the actual quantity required per acre, and then move the indicator a little to the higher side or vice-versa.
9. If the quantity collected from each container is not uniform, then check for the defect in the seed dropping mechanism.
10. Similarly, calibrate for the fertilizer.

Fig 1: Major Components of turbo happy seeder

1. Seed box 2. Fertilizer box 3. PTO drives mechanism 4. Three-point linkage 5. Machine cover 6. Flail cover 7. Drive wheel 8. Stand 9. Furrow openers 10. Extra multi-crop planter seed box attachment 11. Seed and fertilizer box cover 12. Fertilizer rate adjustment lever 13. Seed rate adjustment lever 14. Drive mechanism 15. Fertilizer delivery pipe 16. Seed delivery pipe 17. Frame 18. Flails 19. Seed boot 20. Depth control wheel.

2.3.2 Turbo Happy Seeder Calibration

Fill the seed and fertilizer in the boxes and see the indicator that arranged at proper seed rate. Cover a distance of 50 meters in the field.

Fig 2: Radius of drive wheel and distance between two furrow openers

Take the seed and fertilizer delivery tubes out from the boots and put delivery outlets of the pipes in the politeness bags and tight them using rubber rings. Run the machine and collect the seeds/fertilizers from each delivery pipes after a 50-meter run of the machine. The amount of seed and fertilizer collected from each delivery pipes in the 50-meter run are then weighed in grams. Then we calculate the seed rate and fertilizer rate by the given formula
One acre = 4046 m^2
Width of planter = x (m)
Distance = 50 m
Weight of seed or fertilizer in pipes = y (kg)

$$\textbf{Seed or fertilizer rate (kg/ acre)} = \frac{\text{Weight of seed orfertilizer(kg)} \times \text{area (acre)}}{\text{width of planter (m)} \times \text{distance covered (m)}}$$

If the seed or fertilizer rates are not as per the desired rates, then re-set the indicators or the inclined plates, gears, etc following the desired rates and repeat the whole process of Field calibration as described above.

2.4 Hitching of machine
The machine has three standard hitch points; two lower and one upper. The machine is attached to the tractor through these three hitch points with the help of link pins (Fig.3). The top link hitch point also helps in leveling the machines. The three-point hitch adjustments where the machine fixes to the tractor should be adjusted. The machine should be level from side to side and have just enough forward and backward adjustment to enter the soil at the proper angle.

Fig 3: Hitching of the machine through three-point linkage

2.5 Operation of the turbo happy seeder
With the help of a three-point linkage, the machine is attached to the tractor of optimal capacity (hp) as per the size of the planter. After hitching the planter, the PTO shaft of a tractor is attached to the PTO shaft linkage of the machine which gives drive to the flail with the help of belts The planter is to be calibrated and adjusted as per the requirements i.e., seed rate and fertilizer rate, depth of sowing, plant to plant spacing as per the crop and field conditions. As the tractor moves, the drive wheel starts to rotate which gives drive to the seed and fertilizer shaft. As the shafts start to move, the seed and fertilizer metering (fluted rollers, inclined plates) also start to move and the fertilizer and seed drop fertilizer and seed delivery pipes and further to the seed and fertilizer boots. The seed and fertilizer boots are attached to the slits. Now the fertilizer and seed placed into the soil as the furrow openers are penetrating in soil. As the machine gets power from PTO shaft, the flails start rotating, they clean and shift the residue in front of the furrow openers so as the residues do not drag and accumulate in seed rows.

2.5.1 Tips for the proper working of the machine
The soil moisture must be optimum for the operation of the machine. For proper operation of turbo happy seeder, the soil moisture must be slightly lower than the field capacity. The ruts will be formed if the moisture content of the soil is more than optimum which will lead to the uneven placement of the seeds. To obtain the proper efficacy of the machine (uniform and good plant stand) it is advisable to uniformly distribute the crop residue in the field before operating THS either by straw spreader or manually. There are chances of the more moisture content in the residue in the morning time due to dew which may cause wrapping of the loose straw on the flails which hinders the rotary movement of the flails. Therefore, it is advised to operate the THS after the dew dries. Adjust the depth of sowing through depth control wheels instead of using the hydraulic lift. Using the hydraulic lift to control the sowing depth may cause the touching of flails to the ground which may damage flails and also cause uprooting of the anchored residue. The ground clearance of the flails must be about 2.5 to 3 cm. Broken flail must be replaced before the further operation of the machine. Otherwise, the excessive vibrations in the machine will lead to further breakage of other parts of the machine.

2.5.2 Maintenance
The machine should be properly serviced and maintained. It should be checked before use to ensure that all the details are tightened and that all the parts are in good condition. For example, if the furrow openers are worn out, they should be replaced. If the flails are broken, they must also be replaced. The fertilizer and seed boxes should also be in good condition to allow the free flow of seed and fertilizer. Chains should be adjusted and oiled. The tension of the belt should be proper. After use at the end of each day, the machine should be checked, the seed and fertilizer boxes cleaned, and the moving parts oiled.

3. Results and Discussion
The seed drill and happy seeder were evaluated wheat sown

into rice residues grown on the flat in un replicated experiments at farmers field in Allahabad from December 2015 investigated were harvested by combine have straw spreaders. Combine harvested the rice crops in the experimental and farmers' fields. The soil of the experimental field was sandy loam. The soil pH ranges from 7.2 to 7.8. The bulk density is 1.3 kg/cc. The climate is sunshine and the temperature 25 ^{0}C.

Evaluation of happy seeder

Wheat was sown with the happy seeder into the soil and crop has harvested with a combine harvester with a cutting height 50 to 60 cm. The average rice dry straw load in each experiment was varied from 5.3 to 6.66 t/ha dry height at the time of rice harvest. In another field, the conventional seed drill was used to sow wheat. After the evaluation was performed, the following factors were found.

1. The operating speed of happy seeder could be varied from 2.5 to 3.5 kmph, working of happy seeder was found to be optimum at the speed of 3.5 kmph.
2. The fuel consumption with happy seeder for sowing wheat varied from 4.12-4.36 l/hr and for seed drill 2.96-3.71 l/hr at different operating speeds.
3. The field capacity of happy seeder at 3.5 kmph was 0.29 ha/hr and for seed drill 0.435 ha/hr
4. The field efficiency for happy seeder 43.4% and seed drill was 65%.
5. The cost of operation per hectare by happy seeder was Rs.2098.65 and the cost of operation per hectare by seed drill + tillage operations was Rs.3106.38. Therefore, the cost of operations with happy seeder is economical as compared to seed drill by Rs. 1008.38 per hectare.
6. The crop residue was 0.830 kg/m^2, 0.832 kg/m^2 and 0.839 kg/m^2 of different plots for happy seeder. The crop residue was found heavy.

The following variables are evaluated for happy seeder and seed drill actual field capacity, field efficiency, fuel consumption, and cost of operation. Forward speed is taken as an independent variable cost for the operation of the following data as shown in Tables 1 and 2.

Table 1: Field performance data of the happy seeder sowing wheat

Speed (km/h)	Area(m2) (0.29 ha)	TFC (ha/h)	AFC (ha)	ŋ (%)	Fuel consumption (L/h)
2.5	A1	0.466	0.215	46.78	4.05
	A2	0.478	0.223	46.65	409
	A3	0.532	0.232	43.86	4.12
3.0	B1	0.547	0.241	44.08	4.15
	B2	0.576	0.256	46.80	4.17
	B3	0.597	0.268	44.89	4.22
3.5	C1	0.646	0.267	44.42	4.30
	C2	0.649	0.276	42.52	4.36
	C3	0.667	0.29	43.40	4.40

Table 2: Field performance data of the seed drill sowing wheat

Speed (km/h)	Area(m2) (0.29 ha)	TFC (ha/h)	AFC (ha)	ŋ (%)	Fuel consumption (L/h)
2.5	A1	0.466	0.316	67	2
	A2	0.478	0.300	62	2
	A3	0.532	0.310	58	2.96
3.0	B1	0.547	0.348	63	3.15
	B2	0.576	0.334	57	3.17
	B3	0.597	0.362	60	3.32
3.5	C1	0.646	0.386	56	3.35
	C2	0.649	0.404	62	3.71
	C3	0.667	0.435	65	3.98

4. Conclusion

A happy seeder of nine-furrow opener was tested for its performance in the month of December 2015 at farmer's field in Allahabad. The performance of the happy seeder concerning actual field capacity, field efficiency fuel consumption cost of operation and crop residue condition were studied and compared to a conventional method based on the result obtained as discussed in result, in the following conclusions were drawn.

1. Field capacity increased with an increase in forwarding speed thereafter it decreased, whereas it increases with an increase in the speed of operation.
2. The ground drive wheel skid of tractor increases with an increase in forwarding speed.
3. The fuel consumption increased linearly with the increase in the speed of operation.
4. The overall cost of operation for turbo happy seeder was found to be less than that of the conventional seed drill.
5. The optimum operational depth and speed for both the machines were found to be 4.5 cm and 3.0 km/h respectively.

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