The Pharma Innovation Journal 2019; 8(6): 846-849

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(6): 846-849

www.thepharmajournal.com
Received: 06-04-2019
Accepted: 10-05-2019

Kumudini Verma
M.Tech Student, Dept. of Farm Machinery & Power Engineering, CAE, JNKVV, Jabalpur, Madhya Pradesh, India

Atul Shrivastava
Professor & Head, Dept. of Farm Machinery & Power Engineering, CAE, JNKVV, Jabalpur, Madhya Pradesh, India

Avinash Kumar Gautam
Teaching Associate, Dept. of Farm Machinery & Power Engineering, CAE, JNKVV, Jabalpur, Madhya Pradesh, India

Correspondence
Kumudini Verma
M.Tech Student, Dept. of Farm Machinery & Power Engineering, CAE, JNKVV, Jabalpur, Madhya Pradesh, India

Performance evaluation of tractor drawn round straw baler for paddy

Kumudini Verma, Atul Shrivastava and Avinash Kumar Gautam

Abstract
At present, the cost of the straw gathering is increasing because of increased use of combine harvesters. High labour cost and scarcity of labour make manual collection unfeasible that also encourages the burning of straw in the field after combine harvesting. Burning of a straw causes pollution, increased greenhouse gas emissions and loss of opportunities to worth straw value addition. In the present study performance evaluation of tractor-drawn round straw baler for paddy straw was conducted on combine harvested field. During the field testing data on the straw parameter, machine parameter, and bale parameter were recorded. The actual field capacity, field efficiency, straw recovery and time required for baling was found to be 0.721 ha/h, 93.47%, 94.42%, and 1.26 h/ha respectively with MC 19-21% and speed 3 km/h. But it was found that there is no significant difference in the cost of baling at a different moisture content of straw. So the farmer can use this baler just after the harvesting of paddy, they may save the 12-15 days of time. It is a plus point in the hand of a farmer so, they may use this time for other activities. The benefits of machine are not only economical but also exclude the hazardous effects of burning of crop residues.

Keywords: Round straw baler, baling, hazardous effects of burning

Introduction
India is an agrarian economy. Straw is a natural fibre which we get as a by-product from agriculture. After paddy is harvested, straw is left uncollected on the fields. Combine harvesters for paddy fields are of two types yielding either cut straw or whole straw. In the case of the cut straw harvester, straw is collected behind the tracks or wheels in small pieces after reaping and threshing operation. Collecting these cut straw is cumbersome and laborious as well as labour is scarce and costly, farmers abandon the straw in the fields commonly which decomposes before the next cropping season.

Crop residue is the non-edible plant parts that are left in the field after harvesting. Field residues are materials left on an agricultural field or orchard after the crop has been harvested. These residues include stalks and stubble (stems), leaves and seedpods. These crop residues are used for animal feeding, soil mulching, bio manure making, thatching for rural homes and fuel for domestic and industrial use. Thus crop residues are of tremendous value to the farmers. Production of straw is about 500 Million tonnes in India (GOI, 2016) [1].

Farmers usually burn their straw yield at the end of the rice harvesting season for the fields are prepared for the next crop. Burning rice straw may increase the soil surface layer temperature, causing a sharp drop in winter crop seedling emergence. The frequent straw burning may cause subsoil hardpan, which makes the drainage difficult, restricts seedlings emergence (Agricultural magazine, 1999) [2].

Performance of baler was affected by the following factors:
1) The condition of field surface
2) The condition of the hay
3) The size and uniformity of the windrows
4) The capacity of the picking up and feed mechanisms
5) The forward speed of the baler
6) The amount of power available (Kepner *et al*., 1978) [5]

Therefore, agricultural practices need to manage the crop residual on the harvested field without hazard to the soil, environment, soil fertility, and other factors. To meet the above requirement, the tractor-drawn round baler may help.

Materials and Methods

The moisture content was determined by the standard oven method. The oven was in the range of 0-250 ˚C. The bulk density of straw was determined by standard oven method by putting a known weight of respective sample into an empty graduated jar (1000ml) and the volume occupied by the sample was noted (Mohsenin, 1980) [6]. The treatment selected was the combination of two different moisture content (i.e. ranges 19-21% and 29-31%) and three different speed of operation (i.e. 1.8, 2.4 and 3.0 km/h). The different moisture content was obtained by baling different day after harvesting. So, there were seven treatments along with the manual collection method of straw with 4 replications. The round baler has four major units, the first unit is for picking the windrow straw from the field and then moved through conveying unit (screw type) to compaction unit where the straw is compacted within aluminium ribbed rollers having rotational speed from PTO of tractor equip in the bale chamber to provide the round shape of the bale. Then, a knotter unit is provided to wind up the bales tightly. The weight of bale varied depending upon the moisture content of straw.

The experiment was conducted for evaluating the performance of tractor-drawn round straw baler in the university farm, College of Agricultural Engineering, JNKVV, Jabalpur (M.P.) during the year 2018-19. The experiment was conducted in combine harvested fields for four trials with each treatment. Before the field experiments, variety of crop, average stubble height (cm), average loose straw length (cm), average width of loose straw heaped (cm), weight of straw collected from MS frame of 1 m^2 and loose straw moisture content (%), and bulk density of loose straw (kg/m^3) were recorded at random 10 different locations of the field. During the field evaluation, working width (cm), forward speed (km/h), total time taken and time taken between 2 consecutive bale (min), fuel consumption (l/h), size of bale (cm), and weight of bale (kg) were recorded (NRFMTTI, 2014) [7].

Fig 1: Measurement of stubble height

Fig 2: Determination of bulk density of loose straw

Fig 3: Determination of MC of straw

Fig 4: Weight of bale

Fig 5: Measurement of height of bale

Fig 6: Measurement of diameter of bale

Table 1: Field operational parameters of tractor-drawn round straw baler

S. No.	Particulars	Value
1.	Variety of crop	Paddy (Kranti)
2.	Average stubble height, cm	25-30
3.	Average loose straw length, cm	50-55
4.	Average weight of straw collected from MS frame of 1 m^2, kg	0.510
5.	Average moisture content of loose straw (M_1), %	29-31
6.	Average moisture content of loose straw (M_2), %	19-21
7.	Gear used	L-1, L-2, and L-3
8.	PTO speed	540 (Standard)

9.	Working width of baler, cm	130
10.	Average size of bale (diameter × height), cm	62×63.5
11.	Average bulk density of loose straw for M_1	39
12.	Average bulk density of loose straw for M_2	28

Treatment selected were as shown

T_1-M_1S_1 (At moisture content 19-21% & tractor speed 1.8 km/h)
T_2-M_1S_2 (At moisture content 19-21% & tractor speed 2.4 km/h)
T_3-M_1S_3 (At moisture content 19-21% & tractor speed 3.0 km/h)
T_4-M_2S_1 (At moisture content 21-31% & tractor speed 1.8 km/h)
T_5-M_2S_2 (At moisture content 21-31% & tractor speed 2.4 km/h)
T_6-M_2S_3 (At moisture content 21-31% & tractor speed 3.0 km/h)
T_7-Control (Manual collection method)

Table 2: Field performance parameter of baler

S. No.	Particular	Treatments						
		T_1	T_2	T_3	T_4	T_5	T_6	T_7*
1.	Average speed (km/h)	1.8	2.4	3.0	1.8	2.4	3.0	-
2.	Fuel consumption (l/h)	4.167	3.722	3.350	3.907	3.395	3.122	-
3.	Fuel consumption (l/ha)	6.592	6.654	5.463	6.219	5.089	3.946	-
4.	Actual field capacity (ha/h)	0.557	0.583	0.606	0.629	0.663	0.721	0.028
5.	Field efficiency (%)	87.94	88.67	90.97	91.73	92.10	93.32	83.27
6.	Straw recovery (%)	92.40	92.10	92.34	93.67	93.75	94.42	95.20
7.	Bale output (No of bale/h)	38	40	41	44	45	46	-
8.	Bale output (kg/h)	864.8	910.4	933.16	637.2	651.7	666.2	140.3
9.	Bulk density of bale (kg/m^3)	122	111	121	67	68	75	-
10.	Bale weight (kg)	22.7	23.1	23.5	13.9	14.2	15.3	9.35
11.	Time required between 2 bale (sec)	67	77	72	65	61	53	-
12.	Time required (h/ha)	1.58	1.78	1.63	1.59	1.49	1.26	23.7
13.	Labour requirement (man-h/ha)*	2.08	2.28	2.13	2.09	1.99	1.76	23.7

*T_7 (Manual collection method) it is the weight of loose straw not bales weight.

Fig 7: Field performance of tractor drawn round straw baler

Results and Discussion

The theoretical field capacity was found to be 0.234, 0.312, and 0.39 ha/h when the speed of operation was 1.8, 2.4, and 3.0 km/h respectively.

The maximum actual field capacity (i.e. 0.721 ha/h) was found to be in case of T_6 having lowest moisture content (i.e. 19-21%) and highest speed (i.e. 3.0 km/h) and minimum actual field capacity (i.e. 0.0281 ha/man-h) was found to be in T_7 which was manual collection method. The actual field capacity of T_1, T_2, T_3, T_4, T_5 was found to be 0.557, 0.583, 0.606, 0.629, and 0.663 ha/h respectively.

The maximum field efficiency (i.e. 93.47%) was found to be in case of T_6 having lowest moisture content (i.e. 19-21%) and highest speed (i.e. 3.0 km/h) and minimum field efficiency (i.e. 83.63%) was found in T_7 which was manual collection method. The field efficiency of T_1, T_2, T_3, T_4, and T5 was found to be 88.26, 88.87, 90.79, 91.87, and 92.48% respectively.

The maximum straw recovery (i.e. 96.083%) was found to be in case of T_7 which was manual collection method and minimum straw recovery (i.e. 92.409%) was found in T_1 having highest moisture content (i.e. 29-31%) and lowest speed (i.e. 1.8 km/h). The straw recovery of T_2, T_3, T_4, T_5, and T_6 was found to be 92.103, 92.344, 93.674, 93.752, and 94.423% respectively.

The fuel consumption was minimum (i.e. 3.122 l/h) in case of T_6 having lowest moisture content (i.e. 19-21%) and highest speed (i.e. 3.0 km/h) and maximum (i.e. 6.654 l/h) in T_2 having higher moisture content (i.e. 29-31%) and lower speed (i.e. 2.4 km/h) and it was inconsiderable in case of manual collection. The fuel consumption of T_1, T_3, T_4, and T_5 was found to be 4.167, 3.35, 3.907 and 3.395 l/h respectively.

The time required was minimum (i.e. 1.264 h/ha) in case of T_6 having lowest moisture content (i.e. 19-21%) and highest speed (i.e. 3.0 km/h) and maximum (i.e. 23.7 man-h/ha) in T_7 which was manual collection method. The time required for T_2, T_3, T_4, and T_5 was found to be 1.788, 1.631, 1.592, and 1.499 h/ha respectively.

Bale parameters

The heaviest bale (i.e. 23.535 kg) was found in T_3 and lightest bale (i.e. 13.915 kg) was found in case of T_4. The weight of bale was found to be only 9.35 kg in manual collection method. Weight of bale for T_1, T_2, T_5, and T_6 was found to be 22.76, 23.143, 14.21 and 15.326 kg respectively.

The maximum density (i.e. 132 kg/m^3) of bale was found to be in case of T_3 and minimum density (i.e. 78.174 kg/m^3) of bale was found in case of T_4. The density in case of the manual collection was found to be only 21.16 kg/m^3. The density of bale for T_1, T_2, T_5, and T_6 was found to be 127.77, 130.01, 79.83, and 86.101 kg/m^3 respectively.

The maximum bale output (i.e. 46 bale/h) was found to be in case of T_6 having the lowest moisture content range (i.e. 19-21%) and highest speed (i.e. 3 km/h) and minimum (i.e. 38 bale/h) was found in case of T_1 having highest moisture content range (i.e. 29-31%) and lowest speed (i.e. 1.8 km/h). The bale output in case of T_1, T_2, T_5, and T_6 was found to be 1368.24, 1627.795, 651.76, and 666.25 kg/h respectively.

Percentage saving in volumetric space

It was maximum in case of T_6 and minimum in case of T_7 which was found to be only 16.01% manual collection method with respect to T_6. The percentage saving in space for T_1, T_2, T_4, T_5, and T_6 was found to be 96.65, 98.34, 59.13, 60.39 and 65.39% respectively with respect to T_3.

Labour requirement

The labour requirement was found to be maximum (i.e. 23.7 man-h/ha) in case of T_7 which was manual collection method and minimum (i.e. 1.76 man-h/ha) in T_6 having lowest moisture content range (i.e.19-21%) and highest speed (i.e. 3 km/h).

Energy requirement

Energy requirement was found be maximum (i.e. 399.592 MJ/ha) in case of T_2 and minimum (i.e. 46.452 MJ/ha) in case of T_7 which was manual collection method. The energy requirement for T_1, T_3, T_4, $T_{5,}$ and T_6 was found to be 393.231, 330.182, 371.364, 307.442 and 239.806 MJ/ha respectively and were 2.12, 23.168, 9.422, 30.75, and 53.456% less compared to T_2.

Economic analysis

On the basis of study it can be concluded that the cost of operation was minimum (i.e. 1191.86 Rs/ha) in case of T_6 having lowest moisture content ranges (i.e. 19-21%) highest speed (i.e. 3.0 km/h) and maximum (i.e. 2331.700 Rs/ha) in T_7 which was manual collection method. Whereas, the cost for T_1, T_2, T_3, T_4, and T_5 was found to be 1145.35, 1115.96, 1068.95, 1012.61, and 945.45 Rs/ha respectively which is 50.79, 52.13, 54.15, 56.57, and 59.45% less than T_7. Data revealed that tractor drawn round straw baler for baling of Kranti variety of paddy crop give better performance with T_6.

Comparison of performance of baler at different moisture content

The results were also critically examined for the different moisture content of straw. Table 4.13 shows that at maximum moisture content of straw i.e. range between the 29-31% after the harvesting of paddy, the baler is required more time for baling one bale. It may be due to the more density of straw. Whereas, for less moisture content of straw i.e. 19-21% the machine performance parameters were found to be better than maximum moisture content i.e. 29-31% of straw. But it was found that there is no significant difference in cost of baling at different moisture content of straw.

Conclusion

It was concluded that if farmer use this baler just after the harvesting of paddy, they may save the 12-15 days of time. It is plus point in hand of farmer so, they may use this time for other activities.

Recommendation

Therefore, tractor drawn round straw baler is recommended for baling of paddy (Kranti variety), cleaner environment and to enhance the income of farmers.

References

1. GoI. Annual report. Ministery of New and Renewable energy, New Delhi, 2016. (http://mnre.gov.in). http://www.erewise/current-affairs/biomass-resourse-inindia_art52cbbb9bcd5df.
2. Agricultural Magazine. The scientific face to the black cloud towards best investment of the agricultural Residues, 1999, 17-20.
3. Gautam AK, Shrivastava AK, Samaiya R. Effect of Aqueous Fertilizer on Soil Moisture Content, Depth of Seeding and Seedling Emergence for Wheat.
4. Gautam AK, Shrivastava A, Samaiya RK, Jha A. Design and development of tractor drawn seed cum pressurized aqueous fertilizer drill. Indian Journal of Agricultural Research, 2018, 52(3).
5. Kepner RA, Bainer R, Barger EL. Principle of farm machinery. AVI Publishing Company Inc. USA, 1978, 341-366.
6. Mohsenin NN. Physical properties of plant and animal materials. Gordon and Breach Science Publishers. London, 1980.
7. NRFMTTI. Commercial test report (April) Baler NSE SB 622. NRFMTTI tractor nagar, sirsa road, Hisar, Haryana, 2014, 1-35.
8. Sinha AK, Shrivastava AK, Gautam AK, Ahamad S. A Decision Support System for Farm Mechanization with the Use of Computer Modeling For Soybean-Wheat Crop Rotation. Int. J Innov. Sci. Eng. Technol, 2016, 3(7).