P-ISSN: 2349-8528

E-ISSN: 2321-4902

www.chemijournal.com

IJCS 2020; 8(5): 2490-2493

© 2020 IJCS

Received: 25-06-2020

Accepted: 30-08-2020

Harshaj Singh TutejaM. Tech, FMPE, SVCAET&RS,
IGKV, Raipur, Chhattisgarh,
India**Rajesh Ku Naik**Associate Professor, (FMPE), PI-
AICRP-FIM, SVCAET&RS,
IGKV, Raipur, Chhattisgarh,
India**Shubham Pandey**Ph.D., Scholar, FMPE,
SVCAET&RS, IGKV, Raipur,
Chhattisgarh, India**Corresponding Author:****Harshaj Singh Tuteja**M. Tech, FMPE, SVCAET&RS,
IGKV, Raipur, Chhattisgarh,
India

International Journal of Chemical Studies

Design and evaluation of self-unloading grain collection system for tractor operated axial flow paddy thresher

Harshaj Singh Tuteja, Rajesh Ku Naik and Shubham Pandey

DOI: <https://doi.org/10.22271/chemi.2020.v8.i5ah.10695>

Abstract

India is the second largest country in world with population of 1.356 billion (Census 2017). Rice (*Oryza sativa*) is one of the most important cereals and it is staple food for more than 60% of the world population. The performance evaluation of thresher was studied on paddy variety Mahamaya to ascertain the effect of feed rates (4.5t/h, 5.0t/h, 5.5t/h), moisture content (13%, 15%, 17%) and cylinder speed (15.54m/sec, 17.27m/sec, 19.42m/sec) with four replication. The threshing efficiency, cleaning efficiency, threshing capacity and total losses were 99.42%, 98.91, 2.5t/h, 0.4% respectively at the best and optimum combination of feed rate, moisture content and cylinder speed of 5.0t/h, 15% and 17.27m/sec respectively. Self unloading system of thresher was design and developed by using CATIA V5 2014. There was a cost saving of 2.86%/h and labour saving of 50% over earlier practice.

Keywords: Rice, thresher, threshing efficiency, cleaning efficiency, losses, conveyer

Introduction

In India, the total area under Rice (*Oryza sativa*) is 431.94 lakh hectare and total production is 110.15 million tonnes with average yield of 2550 kg/ha (Department of Agriculture, 2017-18.) Threshing is a key part of agriculture that involves removing the seeds or grain from plants stalk. The threshing operation needs at least 7-8 labour for loading the crop in hopper and unloading the grain from the outlet with constant bending posture. Due to prolonged bending posture the operator gets tired and the working efficiency is also affected adversely. It also leads to body part discomfort, pain at various organs, as well as increase the time of work. Labours are also engaged in collecting grain and bagging it at other place which leads to need of additional labour.

Materials and Methods

The thresher was tested at SVCAET&RS, Faculty of Agricultural Engineering, IGKV, Raipur in the year 2019-20. Self unloading system of thresher was design and developed by using CATIA V5 2014 and fabricated at Gurunanak Agriculture Private Ltd, Kumhari, Raipur. The developed machine was tested for paddy at farmers field as well as at Instructional Research Farm, IGKV, Raipur.

Determination of Efficiencies of thresher

Various efficiencies were the determinable parameters for the performance of a thresher. The following efficiencies were calculated by using formula given in IS: 6234 – 1975.

a. Threshing efficiency was calculated by using the following formula

$$Eth = 100 - Gut \quad \text{---} \quad (1)$$

Where,

Eth = Threshing efficiency of the thresher, %; and

Gut = Percentage of unthreshed grain, %.

b. Cleaning efficiency was calculated by using the following formula

$$Ecl = M/F \times 100 \quad \text{---} \quad (2)$$

Where

Ecl = Cleaning efficiency of the thresher, %;

M = Quantity of clean grain obtained from the sample taken at main grain outlets;

F - Total quantity of the sample taken at main grain outlets.

Analysis of sample

The sample analysis was carried out in the laboratory of Department of Farm Machinery and Power Engineering, IGKV. The samples were weighted with the help of electronic

weight machine. Mahamaya variety was used for threshing. Mahamaya is high yielding variety and can be easily threshed. It is erect and non-lodging.

Determination of moisture content

The moisture content of paddy was determined by air oven method at $70 \pm 2^\circ\text{C}$ and sample of 50 gram clean grain and 200 gram of straw being put for 24 hours (Joshi, 1981). Also for quick determination the moisture content was found with the help of universal moisture meter.

Table 1: Various study parameters

S.NO	Independent parameters	Levels	Dependent parameters
11	Feed rate	F1 = 4.5t/h F2 = 5.0t/h F3 = 5.5t/h	1. Threshing capacity, q/h 2. Cleaning efficiency, % 3. Threshing efficiency, % 4. Different losses, %
2	Moisture content	M1 = 13% M2 = 15% M3 = 17%	
3	Cylinder speed	S1 = 15.54 m/sec S2 = 17.27 m/sec S3 = 19.42 m/sec	

Description and constructional details

The shaft less conveyor consists of a circular or U-shaped tube which rotates the helix. The key components of the screw conveyor are the screw tip, the screw shaft, the trough, the inlet and exit openings, the bearings and the drive mechanism. Screw conveyors range in size from 75 mm to 400 mm in diameter and from less than 1 m to more than 30 m in length. (Hemad *et al.*, 2010; Owen and Cleary, 2009; Labiak and Hines, 1999) [1].

$$Q = \frac{\pi}{4} \times 60 \times D^2 \times S \times \eta \times \rho \times i$$

Where

Q = Capacity of screw conveyor, kg/h;

ρ = Bulk density of the material kgcm⁻³;

D = Nominal diameter of screw, dm;

S = Screw pitch, dm;

Ω = rpm of the screw; and

i = degree of trough filling; %

Capacity of shaftless screw conveyor

Fig 1: Self unloading grain collection system attachment with the thresher**Cost analysis**

The cost of operation for developed attachment was determined by calculating fixed and variable cost. The fixed cost includes depreciation, interest, insurance, housing and taxes while variable cost includes repair and maintainance, fuel, lubrication and labour charges.

Results and Discussion**Effect of feed rate and moisture content on threshing efficiency**

Three feed rate of 4.5 t/h to 5.5 t/h at three different level of moisture content were taken during study. The graph (Fig. 3.1) depicts that threshing efficiency decreased with an

increase in feed rate for all three levels of moisture content. The reason might be at higher feed rate higher intercrop rubbing would take place. The maximum threshing efficiency (99.55%) was found at feed rate of (4.5 t/h) and moisture content (13%) while minimum threshing efficiency (94.33%) was found at feed rate of (5.5 t/h) and moisture content (17%). The similar results were also reported by Ahuja *et al.* (2017) [3].

Effect of feed rate and moisture content on cleaning efficiency

Three feed rate of 4.5 t/h to 5.5 t/h at three different level of moisture content were taken during study. It is evident from

the Fig 3.2 that the cleaning efficiency was decreased with an increase in feed rate for all three levels of moisture content. The reason might be due to increase in feed rate, the amount of material also increased on sieves which reduce the separation of clean grains from straw and chaff. The maximum cleaning efficiency (98.52%) was found at feed rate of (4.5 t/h) and moisture content (13%) while minimum cleaning efficiency (96.38%) was found at feed rate of (5.5 t/h) and moisture content (17%).

Effect of feed rate and moisture content on threshing capacity

Three feed rate of 4.5 t/h to 5.5 t/h at three different level of moisture content were taken during study. The graph (Fig. 3.3) depicts that threshing capacity increased with increase in feed rate for all three levels of moisture content. The maximum threshing capacity (23.4 q/h) was found at feed rate (5.5 t/h) and moisture content (15%) while minimum threshing capacity (18.51 q/h) was found at feed rate (4.5 t/h) and moisture content (17%).

Effect of cylinder speed on threshing efficiency

Three cylinder speed 15.54 m/sec, 17.27 m/sec and 19.42 m/sec at three different level of moisture content were taken during study. It is evident from the Fig. 3.4 that threshing efficiency was increased with increase in cylinder speed. The reason might be during threshing operation at higher cylinder speed higher stripping and impact forces are applied to paddy plant

by threshing drum spikes. The maximum threshing efficiency (99.41%) was found at cylinder speed (17.27 m/sec) and moisture content (15%) while minimum threshing efficiency (98.19%) was found at cylinder speed (19.42 m/sec) and moisture content (17%). The similar results were supported by Dash and Das (1989).

Effect of cylinder speed on cleaning efficiency

Three cylinder speed 15.54 m/sec, 17.27 m/sec and 19.42 m/sec at three different level of moisture content were taken during study. The graph (Fig 3.5) depicts that cleaning efficiency increased with increase in cylinder speed. The maximum cleaning efficiency (98.93%) was found at cylinder speed (17.27 m/sec) and moisture content (15%) whereas, minimum cleaning efficiency (97.29%) was found at cylinder speed and moisture content of 19.42 m/sec and 17% respectively. The similar results were reported by Garg and Madan (1989).

Effect of cylinder speed on threshing capacity

Three cylinder speed 15.54 m/sec, 17.27 m/sec and 19.42 m/sec at three different level of moisture content were taken during study. It is evident from the Fig. 4.5 that threshing capacity was increased with increase in cylinder speed for all three levels of moisture content. The maximum threshing capacity (25.95 q/h) was found at cylinder speed of (19.42 m/sec) and moisture content (15%) while minimum threshing capacity (21.15 q/h) was found at cylinder speed of (15.54 m/sec) and moisture content (17%).

Fig 2: Determination of optimum parameters

Table 2: Rank coefficient assigned for different parameters

Threshing efficiency (%)	Rank Co-efficient	Cleaning efficiency (%)	Rank Co-efficient	Different losses (%)	Rank Co-efficient	Threshing capacity (t/h)	Rank Co-efficient
91	1	91	1	1.0	1	1.6	1
92	2	92	2	0.9	2	1.7	2
93	3	93	3	0.8	3	1.8	3
94	4	94	4	0.7	4	1.9	4
95	5	95	5	0.6	5	2.0	5
96	6	96	6	0.5	6	2.1	6
97	7	97	7	0.4	7	2.2	7
98	8	98	8	0.2	8	2.3	8
99	9	99	9	0.1	9	2.4	9
100	10	100	10	0.0	10	2.5	10

Table 3: Rank co-relation coefficient at optimum feed rate, moisture content and cylinder speed.

Parameters	Feed rate			Moisture content			Cylinder speed		
	4.5t/h	5.0t/h	5.5t/h	13%	15%	17%	15.54 m/sec	17.27 m/sec	19.42 m/sec
Threshing efficiency (%)	8	9	7	8	9	7	8	9	7
Cleaning efficiency (%)	8	9	7	9	10	7	8	9	6
Different losses (%)	8	9	7	8	10	6	8	9	7
Threshing capacity (t/h)	8	10	7	8	9	7	8	10	7
Total Rank Scored	32	37	28	33	38	27	32	37	27

10 = excellent, 8-9 = great, 6-7 = good, 4-5 = ok, 2-3 = bad, 1 = terrible

From above table (4.10 and 4.11) the optimum feed rate, moisture content and cylinder speed was found to be 5.0t/h, 15% and 17.27m/sec respectively. At this optimum range the threshing efficiency, cleaning efficiency, threshing capacity and different losses were found to be 99.42%, 98.91, 2.5t/h,

0.4% respectively. The shaft-less unloading system was designed for optimum capacity of the thresher i.e. for 2.5 t/h. The box (Trapizoidal box) was designed so that it could carry 15 kg of paddy grain at a time and simultaneously it also conveyed to the top of the conveyer.

Table 4: Comparison of cost before and after fitting of the attachment

Particulars	Thresher without developed attachment	Thresher with developed attachment	Increase/ Decrease
Overall cost	Rs 2,15,000	2,35,000	Increase
Depreciation	Rs 80.625/h	Rs 88.125/h	Increase
Interest	Rs 47.3/h	Rs 51.7/h	Increase
Insurance and taxes	Rs 11.825	Rs 12.925/n	Increase
Labour cost	Rs 375/h	Rs 262.5/h	Decrease
Repair and maintenance cost	Rs 10.75/h	Rs 11.75/h	Increase

It was observed that by using thresher with developed self-unloading grain collection system attachment there was a little increase in cost, depreciation, interest, insurance and repair and maintenance cost but there was a large reduction in labour cost around Rs 113/h. Cost of operation of axial flow paddy thresher without self-unloading grain collection system was Rs 687.44/h. But with the developed attachment system cost of operation was reduced to Rs 667.74/ h. Hence there was cost saving of 2.86% over existing system. For operating an axial flow thresher without self-unloading grain collection system 3-4 workers were required for collection and deposition of grains to desired place but with the help of developed attachment only 1 (in case of deposition in sack) or no worker (in case of deposition in trolley) were required. There was saving of 50% labour over earlier practice.

Current Journal of Applied Science and Technology 2017;23(2):1-10.

- Das SK, Das DK. Development of power operated paddy thresher, Agricultural Mechanization in Asia, Africa and Latin America 1989;20(43):37-40.

References

- Hemad Z, Mohammad HK, Mohammad RA. Performance evaluation of a 15.5 cm screw conveyor during handling process of rough rice (*Oriza Sativa* L.) grains. Nature and Science Journal 2010;8(6):66-74.
- Corlett EN, Bishop RP. A technique for assessing postural discomfort. Ergonomics 1976;19(2):175-182.
- Ahuja M, Dogra B, Narang MK, Dogra R. Development and evaluation of axial flow paddy thresher equipped with feeder chain type mechanical feeding system.