RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 5 | Issue 2 | October, 2012 | 186 –191

Performance evaluation of threshing of finger millet by mechanical method

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Received : 10.05.2012; Revised : 30.07.2012; Accepted : 06.09.2012

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■ **ABSTRACT :** The research was conducted on evaluation and testing of threshing methods for finger millet in the Department of Agricultural Engineering. Finger millet *(Eleusine coracana* Craertn) commonly known as ragi is one of the important small millet crops grown in red soil areas of India. It is predominantly cultivated in southern parts of Karnataka. More mechanical damage occurs during threshing process. The traditional methods of threshing are tedious time consuming and inefficient in operation. The experiment was conducted with the varieties of ragi MR1 and HR911. Hence mechanical threshing is a means to overcome the above problems. But so far none of the mechanical threshers available are suited for ragi. At present there is a little information available regarding the mechanical threshers and optimum threshing parameters for ragi crop. Some of the important parameters which influence the threshing efficiency, mechanical damage, moisture content, threshing cylinder speed, feeding rate and concave clearance in mechanical threshing. This method of threshing was experimented at three different moisture content levels of ragi [around 18 to 19, 13 to 15 and 10 per cent (w.b.)]. In mechanical ragi threshing, the raspbar thresher has given the maximum grains output of 140.5 kg/h for variety MR1 and 130.3 kg/h for variety for HR911. The raspbar type thresher showed the least cost for MR1 Rs.18.4 and HR911 Rs.19.5/q for threshing operation. There was not much difference in threshing cost between varieties.

■ **KEY WORDS :** Finger millet, Rasp bar thresher, Threshing, Moisture content, Ragi varieties

■ **HOW TO CITE THIS PAPER :** Prasannakumar and Naveenkumar, D.B. (2012). Performance evaluation of threshing of finger millet by mechanical method. *Internat. J. Agric. Engg.*, **5**(2) : 186-191.

Finger millet *(Eleusine coracana* Craertn) commonly known as ragi is one of the important small millet crops grown in red soil areas of India. It is predominantly cultivated in southern parts of Karnataka. The average yield of the crop under rainfed conditions is about 10 quintals per hectare and under irrigated conditions its about 25 quintals per hectare. The crop occupies an area of 2.5 million hectares and contributes 2.6 million tonnes of grain in India. Its cultivation is concentrated mainly in the states of Karnataka (49%), Orissa (11%), Maharastra (10%), Tamilnadu (9%) and Andhrapradesh (7%), Karnataka stands first both in area (1.06 million ha) and production (1.5 million tonnes). Among all states, Karnataka contributes 54 per cent to country's annual production.

Moisture content of the ear-head plays a key role in threshing operation and seed quality. The traditional methods of threshing are tedious time consuming and inefficient in operation. Hence, mechanical threshing is a means to overcome the above problems. But so far none of the mechanical threshers available are suited for ragi. At present there is a little information available regarding the mechanical threshers and optimum threshing parameters for ragi crop. Some of the important parameters which influence the threshing efficiency, mechanical damage, moisture content, threshing cylinder speed, feeding rate and concave clearance in mechanical threshing.

Hence, the present investigation entitled performance evaluation of threshing of finger millet by mechanical method was undertaken at the University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore with the following objectives: to evaluate the various methods of threshing mechanically, to evaluate the threshing methods for ragi by mechanical thresher, to study the effect of different parameters on threshing output and efficiency in ragi threshing, to determine the optimum operating parameters to obtain maximum threshing output and efficiency and work out the cost and economics of different methods of threshing at optimum operating conditions.

■ METHODOLOGY

This paper deals with the materials used and the methods

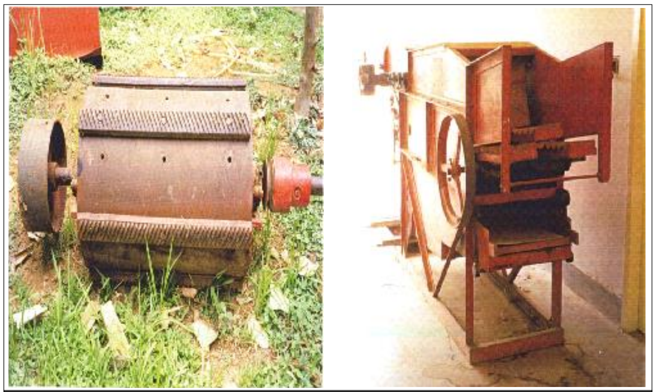

Fig. 1 : Raspbar Thresher

employed in the experiment on evaluation and testing of threshing methods for ragi threshing with respect to grain moisture content output, threshing efficiency, damage, germination percentage and cost of threshing conditions.

The experiment was conducted with the varieties of ragi MR1 and HR911, 4 methods of threshing were adopted at three different moisture content levels of ragi [around 18 to 19, 13 to 15 and 10 per cent (w.b.)] For raspbar type thresher different machine parameter combinations *viz.*, two threshing drum speeds of 800 and 1000 rpm and three concave clearance of 4, 7 and 10mm were evaluated for the best threshing results.

The present study was undertaken at the Regional Research Station, GKVK, UAS, Bangalore.

Experimental details :

Evaluation studies on raspbar type thresher:

The efficiency of threshing, different effective concave clearances and threshing drum speed were recorded.

Feed hopper:

The rectangular hopper was of 124 x 52cm size used to feed the crop and push into the gap between threshing drum and concave. One labour was required to regulate the flow of material into the threshing cylinder. Depending upon the speed of the drum and concave clearance, the feed rate was regulated.

Threshing drum:

The diameter of the threshing drum was 38.18cm and its length was 56cm. The drum speed of 960 rpm and 1200 rpm were used in this experiment. To measure the threshing drum speed a tachometer was used.

Raspbar:

Six numbers of raspbars of size 56 x 5 x 2.5 cm^3 were fixed on the periphery of the threshing cylinder. The distance between two raspbars was 15cm.

Concave:

The concave was adjustable to facilitate the different clearance between concave and drum by operating lever on both sides. The concave width was 34.0cm and concave perimeter was 58cm., the concave clearance of 5, 7 and 11 mm were maintained during the study.

Straw walkers:

Straw walkers were made of wood and fixed on the eccentric shaft which was rotated by connecting to the drum pulley, one labour was engaged to take out the straw from straw walker with tip bent stick and also to remove husk from the husk collector.

Broken straw or husk collector:

The small broken straw or husk during threshing, were made to fall on to husk collector.

Clay and foreign material collector:

Soil and foreign materials like sticks, glass pieces, metal pieces, other plant stalks were removed in this section. The collected materials are removed manually.

Grain outlet:

The grain after passing through oscillating screens was collected in gunny bags at outlet.

Oscillating screens:

Two screens were fixed one above the other. The upper screen was 3mm size and lower one was 1.8mm size. The threshed grains passed through these screens and collected through the outlet. The screening unit size was 54.5cm length and 51.5cm width.

Blower:

Fan shaft has a diameter of 9.0cm. The fan of the blower unit was rotated at a speed 1870rpm. The air velocity from the blower was measured by using an anemometer, at threshing drum speed of 900 rpm, the air velocity was 8 m/s, and at 1200 rpm it was 10 m/s. The air velocity readings were taken with an anemometer and average value was calculated.

Power unit:

The thresher was operated by a 5hp diesel engine running at 1440 rpm. Experimental procedure the threshing studies were conducted with MR1 and HR91 1 varieties of ragi crop harvested at the physiological maturity stage. The crop to be threshed was weighed using a spring balance (about 50 kg) for each treatment in three replications.

Working of raspbar thresher:

The thresher was adjusted according to the recommendations of the company. To adjust the speed of the thresher cylinder, it was run for few minutes without feeding the crop. The speed of the drum, clearance and working of oscillator, speed of the fan, were recorded. All the belts were checked for running with correct tension and in the correct direction and the movement of the straw walker checked. The crop was fed carefully to avoid damage to the hands and to avoid accidents.

After all the adjustments were made, the experiment was conducted. The feed rate was varied depending upon the speed of the drum and concave clearance. The time taken to thresh 50kgs of ragi at combination of different speeds (960 and 1200 rpm) and different concave clearance (5, 7 and 11mm) were recorded. Two men were required to feed the crop and one man for removing the straw from the straw walker. The same threshing method was followed for every treatment in three replications, the weight of the threshed grain, straw and unthreshed grain and damaged grain were recorded separately for each treatment in three replications. The average was calculated and analysed.

Three samples of crop of 50kg each were taken which were threshed at a cylinder speed of 960 rpm and 1200 rpm at different concave clearance and at different levels of moisture content. The physical damage to the seeds was observed and such seeds were separated and weighed. The damaged seeds were expressed as percentage by weight.

The following observations were recorded and parameters computed during the studies

Parameters recorded:

– Speed of the threshing cylinder (rpm)
– Weight of the crop fed into the thresher (kg)
– Weight of the threshed grain (kg/h)
– Weight of the unthreshed grains (kg/h)
– Weight of the damaged grains (kg)
– Seed moisture content (%)
– Blower air velocity (m/s)
– Concave clearance (mm)
– Time required to thresh 50 kg crop (h)

Economics of threshing of ragi:

The economic feasibility of different threshing methods was studied for threshing of ragi crop. The following assumptions were made for calculation.

Capital investment:

Cost of raspbar type thresher = 50,000/-
Life span of the machine = 10 years
Scrap value = 10 per cent of the initial investment
Housing and shelter cost - one per cent of the machinery cost per annum
Annual interest rate on capital - 15 per cent
Energy rate - Rs.6 per kw (electricity)
Fuel consumption of diesel engine - 1 litre/hr, Rs.18/l
Lubrication - 15 per cent of the fuel cost
Number of labours required per day at the rate of 150 Rs./labour. Three labours for thresher.

Statistical analysis:

Fisher's method of analysis of variance as described by Sunder Raj *et al.* (1972) was adopted for the analysis of the experimental data. Levels of significance used in 'F' test and 't' test were at (P=0.05). The results were described in the test at this probability level.

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussion have been summarized under following heads:

Evaluation studies on raspbar type thresher:

The observations on the crop feed rate of raspbar type thresher as influenced by different threshing drum speed (960 and 1200 rpm) and concave clearance 5, 7 and 10mm are presented in Table 1 to 6.

Effect of concave clearance, threshing drum speed and moisture content of the grain on threshing efficiency:

The observations on threshing efficiency for ragi varieties MR1 and HR911 when subjected to threshing in raspbar type thresher at different concave clearances, threshing drum speeds and grain moisture content levels are presented in Table 1 and 2, respectively. The threshing efficiency due to interaction effect between concave clearances, threshing drum speeds and grain moisture content

Table 1 : Threshing efficiency (%) of the raspbar type thresher for MR1 ragi variety at different drum speed, concave clearance and moisture content

Concave clearence (mm)	Threshing efficiency (%)							
	Drum speed 960 rpm				Drum speed 1200 rpm			
	Moisture content				Moisture content			
	18.20%	15.20%	9.8%	Mean	18.20%	15.20%	9.8%	Mean
5mm	68.97	72.39	78.38	73.25	71.63	73.37	79.63	74.88
7mm	67.83	71.77	75.06	71.35	68.27	72.17	78.22	72.89
1 l mm	63.20	69.66	71.93	68.26	64.91	69.83	72.30	69.01

Table 2 : Threshing efficiency (%) of the raspbar type thresher for HR911 ragi variety at different drum speed, concave clearance and moisture content

Concave clearance (mm)	Threshing efficiency (%)							
	Drum speed 960 rhm				Drum speed 1200 rpm			
	Moisture content				Moisture content			
	18.90%	13.40%	10.10%	Mean	18.90%	13.40%	10.10%	Mean
5mm	66.13	70.95	75.47	70.85	67.76	72.86	76.38	72.40
7mm	64.34	69.71	74.89	69.65	64.04	71.91	74,84	70.26
11mm	63.20	66.24	67.75	65.73	63.95	66.71	68.80	66.49

levels did not differ significantly.

Variety MR1:

The threshing efficiency at threshing drum speed of 960 rpm and 1200 rpm, concave clearance of 5, 7 and 11 mm and grain moisture content of 18.2, 15.2 and 9.8 per cent are presented in the Table 1 and 2, respectively.

The highest threshing efficiency of 79.6 per cent was obtained at combination of 5mm concave clearance, 1200 rpm threshing drum speed and grain moisture content of 9.8 per cent. And the lowest threshing efficiency of 66.1 per cent was obtained at combination of 11mm concave clearance 960 rpm threshing drum speed and grain moisture content of 18.2 per cent, respectively.

Variety HR911:

The highest threshing efficiency of 79.0 per cent was obtained at combination of 5mm concave clearance, 1200 rpm threshing drum speed and grain moisture content of 10.1 per cent. And similarly the lowest threshing efficiency of 69.0 was recorded at combination of 11 mm concave clearance, 960 rpm threshing drum speed and grain moisture content of 18.9 per cent, respectively.

Effect of concave clearance, threshing drum speed at different grain moisture content levels on threshing operation cost:

The observations of the threshing operation cost of the ragi verities MR1 and HR911, when subjected to different concave clearance and threshing drum speeds at different levels of grain moisture content of grain are presented in Table 3 and 4, respectively.

Variety MR1:

The threshing operational cost at threshing drum speed of 960 rpm and 1200 rpm at 5, 7 and 11mm concave clearance and grain moisture content levels 18.2, 15.2 and 9.8 per cent.

The highest cost for threshing operation Rs.32.00/q was at combination of 7mm concave clearance, 960 rpm threshing drum speed and grain moisture content of 18.2 per cent. And the lowest cost for threshing operation is Rs.18.4/q was at combination of 5 mm concave clearance, 1200 rpm threshing drum speed and grain of 9.8 per cent, respectively.

Table 3 : Threshing operation cost (Rs. q) for raspbar type thresher at different concave clearance, drum speed and moisture content of grain for MR1 ragi variety

Concave Clearance (mm)	Threshing operation cost (Rs./q)							
	Drum speed 960 rpm				Drum speed 1200 rpm			
	Moisture content				Moisture content			
	18.20%	15.20%	9.80%	Mean	18.20%	15.20%	9.80%	Mean
5mm	28.67	23.42	20.16	24.08	24.46	22.91	18.46	21.94
7mm	30.78	25.81	21.64	26.08	26.48	24.81	19.52	23.60
11 mm	30.73	22.47	21.12	21.77	26.83	21.94	21.17	23.31

Table 4 : Threshing operation cost (Rs. /q) for raspbar type thresher at different concave clearance, drum speed and moisture content of grain for HR911 ragi variety

Concave clearance (mm)	Threshing operation cost (Rs./q)							
	Drum speed 960 rpm				Drum speed 1200 rpm			
	Moisture content				Moisture content			
	18.90%	13.40%	10.10%	Mean	18.90%	13.40%	10.10%	Mean
5mm	31.09	25.71	20.74	25.85	28.12	25.99	20.96	25.02
7mm	32.24	27.26	23.13	27.54	28.09	25.68	20.09	24.62
11 mm	34.24	28.74	22.10	28.36	28.44	25.03	21.68	25.05

Table 5 : Effect of concave clearance, threshing drum speed and grain moisture content on mechanical damage in rasphar type thresher for MRI ragi variety

Concave clearance (mm)	Mechanical damage (%)							
	Drum speed 960 rpm				Drum speed 1200 rpm			
	Moisture content				Moisture content			
	18.20%	15.20%	9.80%	Mean	18.20%	15.20%	9.80%	Mean
5mm	0.83	1.63	1.65	1.03	1.03	1.97	2.97	1.97
7mm	0.67	1.33	1.83	1.28	0.77	1.63	2.13	1.51
11 mm	0.43	0.87	1.23	0.84	0.57	1 .13	1.57	1.09

Table 6 : Effect of concave clearance, threshing drum speed and grain moisture content on mechanical damage in raspbar type thresher for HR911 ragi variety

Concave clearance (mm)	Mechanical damage (%)							
	Drum speed 960 rpm				Drum speed 1200 rpm			
	Moisture content				Moisture content			
	18.90%	13.40%	10.10%	Mean	18.90%	13.40%	10.10%	Mean
5mm	0.83	1.67	2.17	1.56	1.03	1.87	2.70	1.87
7mm	0.63	1.17	1.16	1.16	0.80	1.43	1.80	1.34
11 mm	0.43	0.87	1.17	0.82	0.53	1.03	1.33	0.96

Variety HR 911:

The highest cost of threshing operation was Rs.38/q at combination of 11mm concave clearance, 960 rpm threshing drum speed and grain moisture content of 18.9 per cent. The lowest cost of threshing operation was Rs.22/q at combination of 7mm concave clearance, 1200 m/min threshing drum speed and grain moisture content of 9.8 per cent, respectively.

Effect of concave clearance, threshing drum speed at different grain moisture content levels on mechanical damage:

The observations of the mechanical damage of the ragi verities MR1 and HR911, when subjected to different concave clearance and threshing drum speeds at different levels of grain moisture content of grain are presented in Table 5 and 6, respectively.

Variety MR1:

The mechanical damage at threshing drum speed of 960 rpm and 1200 rpm at 5, 7 and 11mm concave clearance and grain moisture content levels 18.2, 15.2 and 9.8 per cent.

The highest mechanical damage for threshing operation was 2.97 per cent at combination of 5mm concave clearance, 1200 rpm threshing drum speed and grain moisture content of 9.80 per cent. And the lowest mechanical damage for threshing operation was 0.43 at combination of 5 mm concave clearance, 960 rpm threshing drum speed and grain of 18.20 per cent, respectively.

Variety HR 911:

The highest mechanical damage for threshing operation was 2.70 per cent at combination of 5mm concave clearance, 1200 rpm threshing drum speed and grain moisture content of 9.80 per cent. And the lowest mechanical damage for threshing operation was 0.43 at combination of 5 mm concave clearance, 960 rpm threshing drum speed and grain of 18.20 per cent, respectively.

Conclusion:

In ragi threshing method, the raspbar thresher has given the maximum grains output of 140.5 kg/h for variety MR1 and 130.3 kg/h for variety for HR911. The raspbar type thresher showed the least cost for MR1 Rs.18.4 and HR911 Rs.19.5/q for threshing operation compared to other three threshing methods. There was not much difference in threshing cost between varieties.

Even though the mechanical damage to grain was high and germination of seed was less when threshed at lower (10%) grain moisture content. The output of the threshed grain, threshing efficiency and cost of threshing operation were lower. So threshing of ragi crop at 10 to 13 per cent grain moisture content is recommended for adoption.

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