Pertanika 7(2) 53–59 (1984)

Performance Evaluation of a Simple, Locally-Designed Padi Thresher

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Key words : Threshing capacity; threshing efficiency; product purity.

RINGKASAN

Penilaian terhadap sebuah mesin pelerati padi yang direkabentuk di Universiti Pertanian Malaysia Cawangan Sarawak menunjukkan bahawa ia adalah sebuah mesin yang berkeupayaan tinggi. Dengan menggunakan tenaga manusia, pelerai ini berkeupayaan melerai padi sekadar 45 hingga 68 kg./jam. Kebolehan dan kekuatan pengguna pelerai itu boleh menentukan kadar peleraian sebenar. Walau bagaimanapun, apabila menggunakan kuasa enjin, pelerai ini dapat melerai 121.3 kg./jam. Kecekapan peleraian adalah 87% atau lebih dan ketulenan hasil pula ialah 79% atau lebih. Kemungkinan penanam-penanam padi akan menggunakan pelerai ini adalah cerah kerana keupayaan pelerai ini adalah lebih tinggi dari peleraian secara insani bagi tiap-tiap satu jam bekerja. Tambahan pula, ia murah, ringan dan senang dibuat.

SUMMARY

Performance evaluation studies of a padi thresher designed at Universiti Pertanian Malaysia Cawangan Sarawak indicated that it was a high capacity thresher. Using manual labour, it was capable of threshing padi at a rate of 45 to 68 kg/hr. The skill and the physical power of the operator determined the actual rate of threshing. However, when engine powered, threshing was accomplished at a constant 121.3 kg/hr. Thresing efficiency was found to be 87% or higher and product purity was 79% or higher. The possibility of this thresher being adopted for use by padi farmers is good because there is a marked increase in output per man-hour over manual threshing. In addition, it is cheap, light and easy to fabricate.

INTRODUCTION

Padi production in Malaysia is basically a small-holding enterprise. Each family operates a small farm, producing enough rice for family consumption until the next season's harvest. The predominant form of smallholder technology is based on manual labour provided by members of the family. The main attributes of this technology are that it is low-cost, family-oriented and well-suited to the traditional farming methods. However, manual labour involves hard and tedious work.

With the introduction of new, high-yielding padi cultivars, coupled with the continued exodus of rural youths to the industrial centres, padi production has become too labourious and difficult for many farmers. The traditional harvesting method, for example, involves the use of the 'tuai' or sabit (Peninsular Malaysia) or 'ketap' (Sarawak), a small knife that will cut the padi panicles with 5 to 8 cm of straw. Subsequent threshing is done by foot trampling which is a drudgery and labour consuming. And studies have shown that traditional harvesting and threshing costs constitute the highest cost in padi production (Sapuan, 1977).

A portable padi thresher was designed at the Universiti Pertanian Malaysia Cawangan Sarawak with a view to reduce labour requirements and to increase threshing capacity and efficiency of the operation. Performance evaluation studies of the thresher are reported in this paper.

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MATERIALS AND METHODS

A portable padi thresher was designed and fabricated at the Universiti Pertanian Malaysia Cawangan Sarawak. Thresher design and mode of operation are as illustrated in Figures 1, 2 and 3.

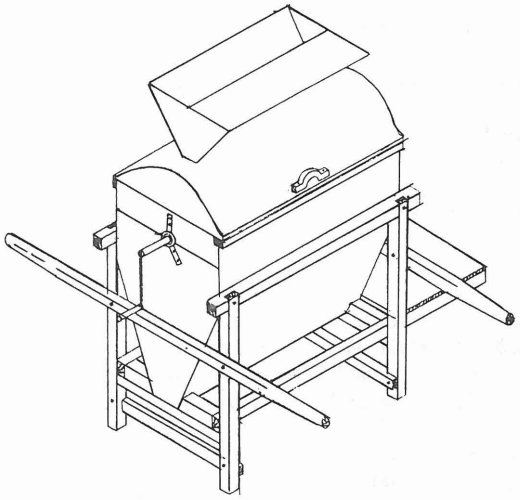


Figure 1. Three dimensional view of the Thresher

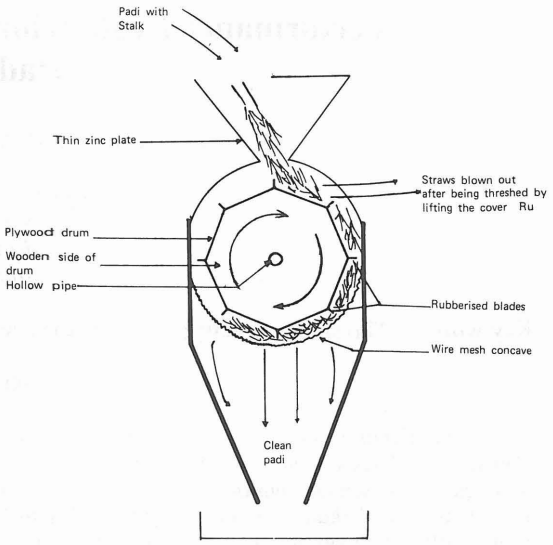
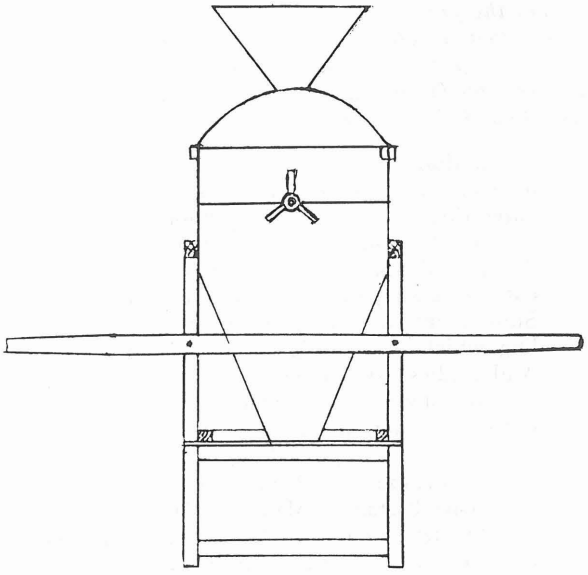


Figure 3: Operation of the Thresher



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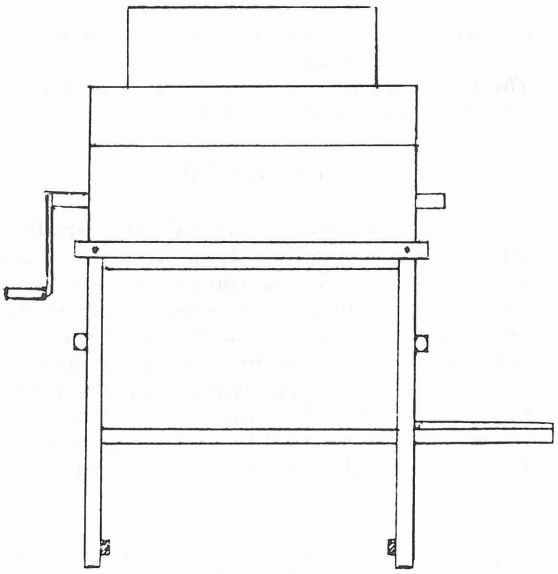

Pandangan Hadapan

Figure 2: The Profile and Front view of the thresher.

For the purpose of evaluation, the drum of the thresher was rotated either manually or powered by a 3 h.p. Briggs and Stratton engine. Regardless of the source of power, threshing was accomplished by the following sequence of operation. Padi panicles were inserted through the top of the threshing drum. When these materials came in contact with the cylinder, an impact was created and this caused shattering of the grains from the straw. Further threshing was accomplished as a result of the rubbing action as the materials were accelerated and passed through the restricted clearance between the cylinder and the concave. Separation of grains from the straw occurred at the concave which was made of corrugated wire mesh with openings big enough for the grains to pass through and were collected at the discharge spout located at the bottom of the thresher. The straw remained on the mesh and was carried to the top by the thresher blades. The straw would be pushed out of the thresher when the lid was opened because of the centrifugal force created by the rotating drum.

Manual powered evaluation

One-kilogram lots of padi on panicles at 12.3% moisture content were threshed by inserting them into the thresher one lot at a time. Five revolution settings of 20, 30, 40, 50 and 60, were used. These provided threshing time of 15, 21, 27, 35 and 41 seconds, correspondingly. One lot of padi was used for each revolution (or time) setting. Materials collected at the delivery spout, trash outlet and those retained in the machine were weighed separately after each threshing. Machine loss, threshing efficiency and the purity of product were determined.

In another set of tests, threshing was done continuously but the recovery of products at the discharge spout was done at a specified 10 second intervals. Product purity and threshing efficiency were determined for each product recovery. The procedure was adopted in order to determine the optimum product purity at *100% threshing efficiency.*

Engine powered evaluation

The speed of the rotating drum at the time of threshing was set at a constant 2200 r.p.m. The revolution was determined by placing a tachometer against the pulley attached to the central shaft of the rotating drum. Three different threshing times of 97, 103 and 137 seconds were used for each lot of grains (on panicles). The weight of each lot of grains varied with each different time setting. However, the moisture content was the same, 17.2%. Threshing procedures were similar to those described in the evaluation for the manually powered thresher.

RESULTS AND DISCUSSION

Manual Operation

Results of the evaluation studies are presented in Tables 1 and 2.

From Table 1, it can be seen that machine loss was highest (3.5%) at the lowest revolution setting of 20 revolutions. After 20 revolutions, there were still padi grains attached to the straw that was discharged out of the thresher. However machine loss decreased as the number of revolutions increased indicating that sufficient threshing can take place before the straw is discharged. Threshing efficiency was lowest with the lowest revolution. This increased with an increase in the number of revolution. As threshing time increased more threshing was accomplished. The purity of product decreased with increased threshing time. As threshing time was extended more empty grains and pieces of straw became detached from the panicles and were discharged together at the discharge spout.

Table 2 shows the actual materials recovered from the discharge spout over a determined time of threshing. Generally, it was found that the purity of product decreased as the threshing time was increased. However, threshing efficiency improved with increased threshing time. Thresher capacity was found to be 68 kg/hr of raw product (filled grains and other materials collected at the discharge Spout were not separated). Labour capacity was found to be 34 kg/man-hr for raw product and the average purity of product was 84.7% with 100% threshing efficiency.

Engine Operation

The results of the evaluation are presented in Table 3. Threshing efficiency was 100% and the average product purity was found to be 82.1%. Threshing capacity was 158.5 kg/hr (raw product) or 121.3 kg/hr (clean padi). Fuel consumption was good for 107.1 kg of padi could be threshed using only 1 litre of fuel.

The performance of this thresher depends on the speed of the rotating (threshing) drum, the length of threshing time and the quantity of padi (on panicles) inserted at any one time. Crop variables such as cultivars, stage of maturity and grain (and straw) moisture content could have an influence as well. The judgement of the operator played a prime role in the determination

TABLE 1

Operation : Manual

Location : Universiti Pertanian Malaysia Cawangan Sarawak farm

Date	21 – 4 1983					29 – 4 – 1983		
Moisture content	12.3%					–		
Number of revolutions (rpm)	20	30	40	50	60	–	–	–
Time thresh (sec)	15	21	27	35	41	69	85	98.5
At Delivery Spout								
Weight of paddy and trash (gms)	750	867.5	883.3	925	875	1700	2020	1650
Weight of clean paddy (gms)	728	803	835.3	876	839	1600	1850	1300
At trash outlet and inside machine								
Weight of paddy with stalk (gms)	108	49	26.3	10	15.5	0	0	0
Weight of paddy (gms)	25	14	7.0	7.5	7.5	0	0	0
Calculations								
Machine loss (%)	3.5	1.5	1	1	1	0	0	0
Threshing efficiency (%)	87	94	97	99	98	100	100	100
Purity of product (%)	97	96	94.7	94.5	95.5	94	92	79

TABLE 2

Operation : Manual

Location : Universiti Pertanian Malaysia Cawangan Sarawak farm

Date : 19.5.1983

Moisture content : 15.82

	Time (sec)	Wt. of paddy and trash	Wt. of paddy	Total Wt. of paddy and trash	Total Wt. of Paddy	Purity of product (%)	Threshing efficiency
Test I	18	788	714	788	714	90.61	
	28	94	62	882	776	87.98	
	38	17	12	899	788	87.65	
	48	8	7	907	795	87.65	100%
Test II	18	780	627	780	627	80.38	
	28	114	95	894	722	80.76	
	38	22	14	916	736	80.35	
	48	10	7	926	743	80.24	100%
Test II	25	746	665	746	665	89.14	
	35	156	116	902	781	86.58	
	45	17	15	919	796	86.61	
	55	16	10	935	806	86.20	100%
Test IV	23	644	542	644	542	84.16	
	33	148	128	792	670	84.60	
	43	37	26	829	696	83.96	
	53	20	14	849	710	83.63	100%
Test V	28	712	630	712	630	88.48	
	38	196	158	908	788	86.78	
	48	40	30	948	818	86.29	
	58	19	14	967	832	86.04	100%
Test VI	25	594	512	594	512	86.20	
	35	263	227	857	739	86.23	
	45	53	36	910	775	85.16	
	55	22	14	932	789	84.66	100%
Thresh Outlet		0	0	0	0		

Thresher Capacity : 68.1 kg/hr
Labour Capacity : 34.1 kg/man. hr
Threshing efficiency : 100%
Average purity of Product : 84.7%

TABLE 3

Operation : Engine power

Engine : Single cylinder, air-cooled 4 cycle Briggs and stratton, 3hp.

Enginerpm : 1500 rpm

Pulley driving threshing drum: 2200 rpm.

Location : Universiti Pertanian Malaysia Cawangan Sarawak farm

Date : 21.5.1983

Moisture content : 17.2%

	I	II	III	Overall
Total Weight (kgm)	7.5	4.05	6.15	17.70
Number of tests	3	3	4	
Number of feeding/test	4	4	4	
Average weight/feed (kgs)	0.625	0.338	0.384	
Delivery Outlet				
Weight of padi and trash (kg)	7.0	3.85	5.65	16.50
Weight of clean padi (kg)	5.2	2.95	5.4	13.55
Weight of padi with straw (kg)	0	0	0	0
Trash Outlet				
Weight of padi (kg)	0	0	0	0
Weight of padi with straw (kg)	0	0	0	00
Threshing time (seconds)	103	97	137	137
Cleaning time (seconds)	13	23	19	55
Calculations				
Threshing efficiency (%)	100	100	100	100
Purity of product (%)	74	76.6	95.6	82.1
Threshing Capacity (raw) kg/hr	214	121.5	141.9	158.5
Threshing Capacity (Clean paddy) kg/hr	148	88.5	124.6	121.3
Labour Output (kg/man hr)	148	88.5	124.6	121.3
Fuel consumption (ml)		25ml	75ml	
Fuel consumption rate (ltr/hr)		0.75	1.24	
(clean paddy) kg/ltr.				107.1

of the efficiency of the thresher. He has to decide when the lid should be opened to discharge the straw and other light materials. Delayed opening could result in decreased product purity but opening the lid too soon may result in substantial machine loss. The authors believe that this thresher has a good potential for adoption by the padi farmers. The main materials for the fabrication of this thresher is wood and a bit of zinc and corrugated wire mesh. As such it is cheap, easy to fabricate and light (very portable). It requires two persons to operate it manually but only one person if it is engine powered.

ACKNOWLEDGEMENT

The authors wish to acknowledge the help given by all the laboratory personnel of the Engineering Division at Universiti Pertanian Malaysia Cawangan Sarawak, and especially Mr. Ahmad Apot and Mr. Mohd. Ahmad for their untiring efforts in carrying out work related to the project. They would also like to thank Universiti Pertanian Malaysia for partly funding this research through Grant 1716–1–449.

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(Received 10 January, 1984.)

Appendix 1

Calculations

1. Threshing efficiency = $\frac{\text{wt. of threshed grains}}{\text{total wt. of grains}}$

2. Purity of product = $\frac{\text{wt. of cleaned grains}}{\text{total wt. of grains with trash}}$

3. Cleaning efficiency = $\frac{\text{wt. of trash at outlet}}{\text{total wt. of trash collected}}$

4. Thresher loss = $\frac{\text{wt. of clean grains at outlet}}{\text{total wt. of clean grains}}$

5. Thresher out put = $\frac{\text{wt. of clean grains}}{\text{output time}}$

6. Thresher capacity = $\frac{\text{thresher output}}{\text{engine power}}$

7. Labour capacity = $\frac{\text{thresher capacity}}{\text{total labour used}}$