Design of appropriate technology machine for semi automatic rice thresher to increase productivity and quality of rice hygiene Bukit Batu Bengkalis District - Riau

Razali[1], Syahrizal[2], Muhammad Khafidz[3]

{razali@polbeng.ac.id[1], syarizal@polbeng.ac.id[2]}

[1,2]Department of Mechanical Engineering Politeknik Negeri Bengkalis

Abstract. One of the ways to increase agricultural production is to apply appropriate and low- cost technological innovations.Especially in terms of handling yields, namely threshing rice mechanically (using a machine) because it is faster, the output is clean and does not tire farmers. Based on data from the PublicWorks and Public Housing Office of Bengkalis Regency, 29 December 2020, the area of paddy fields is approximately 545 hectares spread over 5 (five) villages, namely Parit 1 Api-Api Village with an area of 255 hectares, Api-Api Village with an area of 75 hectares. Ha, Sukajadi Village with an area of 85 Ha,Bukit Batu Village with an area of 80 Ha and Temiang Villagewith an area of 50 Ha. Seeing the incident above, the author tries to design and build a grain thresher machine with its workto maximize good and quality rice yields. The results of testingthe performance of the rice threshing machine for threshing ricewith a screw conveyor and blower system is the level of cleanliness of the threshing grain, which is 95%. Meanwhile, the working capacity of the rice thresher reaches 251 kg of rice/hour (straw input capacity is 416 kg/hour). So there is an increase in the working capacity of the rice thresher by 58%. While the increase in the quality of rice cleaning is 3.1% compared to the reference rice thresher.

Keywords: Thresher Machine, design, semi-automatic, *Bukit Batu.*

1 Introduction

Based on data from the Public Works and Public Housing Service of Bengkalis Regency on 29 December 2020, the area of rice fields is approximately 545 hectares spread over 5 (five)villages, namely Parit 1 Api-Api Village with an area of 255 hectares. Api-Api Village with an area of 75 hectares. Sukajadi Village covers an area of 85 Ha, Bukit Batu Village covers an area of 80 Ha and Temiang Village covers an area of50 Ha Most farmers in the Riau region, especially Bengkalis Regency, still carry out post-harvest processing using manual or traditional methods, especially in the process of threshing the rice grains from the stems. Traditional threshing of rice will result in relatively large spread shrinkage, poor grain quality and a lot of dirt mixed in the rice threshing, causing farmers to have to clean it manually with the help of the wind [1]. The process of threshing rice during harvest causes the operator to have to work standing on one leg so that he can pedal the rice thresher which is quite tiring and takes a long time in the threshing process. After the grain is threshed, the quality of the grain in terms of

ABEC 2023, September 21, Bengkalis, Indonesia

DOI 10.4108/eai.21-9-2023.2342962

grain purity decreases and is not sufficient for marketing. This decrease in quality is caused because the grain is still mixed with impurities from empty grain, stems or other parts of grain, seeds from other varieties, weeds and other impurities carried during harvest. One of the ways to increase agricultural production is to apply appropriate and low- cost technological innovations. Particularly in terms of harvest handling, namely mechanical threshing of rice (using a machine) is clearly more profitable, because it is faster, the yield is cleaner and it doesn't tire the farmer. Seeing the incident above, the author tries to design and build a grain thresher machine that functions to maximize good and quality rice yields [2]. The aims of this research are to design and build a rice threshing machine to increase productivity and clean quality of rice and to test the performance of the rice thresher. Development Concept. In the concept development phase, the needs and wants of the target market are identified, alternative product concepts are generated and evaluated and a concept is selected for further development [3]. Design Level System. The systems design phase includes defining the product architecture and dividing the product into subsystems and components [4]. The final assembly scheme for a production system is usually not clearly defined during this phase. Design Details. Overall specifications in two dimensions, materials to be used and tolerances of all unique product components and identification of all standard components to be purchased from suppliers. Testing and Screening. The testing and screening phase involves establishing and pre-production evaluation of the many types of products to be developed. There are several designs of machine elements used to make rice threshing machines. The following machine elements are used

a. Motor Power

Table 1. Correction factor for the power to be transmitted

Correction Factor	
Power Transmitted	*fc*
Average power	1,2-2,0
Maximum power	0,8-1,2
Strength	1,0-1,5

Power Plan

Fc = Correction factor = 1,2P = Motor Output Power
= 1 Hp = 0,7457 KW
Pd = f_c x *P*...(2.1)

b. The calculation for the shaft is as follows:

Calculate the design power
Pd=fc.P (Sularso,2004:7)..(2.2)

Where:
Pd= Plan power (Kw)
Fc = correction factor
P = Nominal power (Kw)
Calculate the design moment that occurs on the shaft:

D_2 = Driven pulley (mm)D_1 = Drive pulley (mm)

d) Belt Calculation The V-belt as a power transmission from the motor to the reducer,(can be calculated) by the formula [5]:

- Belt Speed

$V = \frac{\pi(D1)(n1)}{}$.. (2.5)12

Where:

V = belt speed (m/s)

d = motor pulley diameter (mm)

n = combustion engine rotation (rpm)

- Belt length

$L = 2(C) + \frac{\pi}{2}(D1 + D2)$ .... (2.6)

Where:

L = belt length (mm)

C = shaft axis distance (mm)

D1 = drive pulley diameter (mm)D2 = pulley shaft diameter(mm)

2 Research Method

The method used in this research is a qualitative method (in the form of descriptive data), with a research approach method, namely case studies with Quality Function Deployment (QFD)analysis techniques [7]. The data collection technique is observation, documentation and interview methods. The stages are as follows

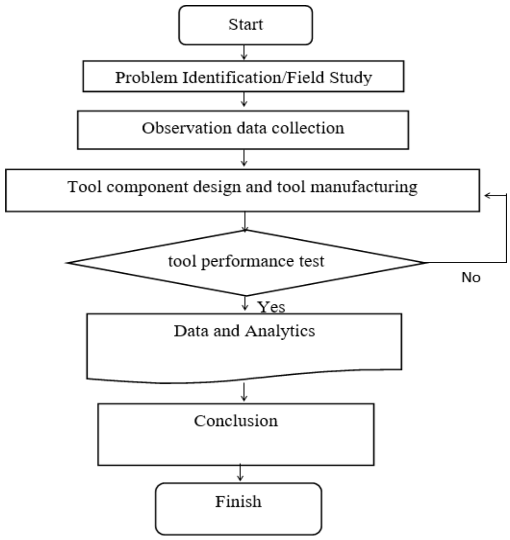

Figure 1. Research flow diagram

3 Result

3.1 Concept Selection

The results of testing the performance of the rice threshing machine for threshing rice with a screw conveyor and blower system is the level of cleanliness of the threshing grain, which is 95%. When compared with the percentage of cleanliness produced by the Reference comparison engine, it is only 91.9%.So the increase in rice cleaning quality is 3.1% compared to the reference rice thresher. Selecting or selecting a concept is a process of evaluating several existing concepts with respect to the specified criteria in meeting consumer needs. In this selection, a comparison was made of the strengths and weaknesses of each concept and took one of them that was deemed worthy of further development. The external decision method is a method of selecting a design concept by returning it to the intended target market/consumer. Some of the concept drawings offered to the farmers as a result of the concept screening are:

Table 2. Concept Screening Matrix

Concept Criteria	**Ref**	**Design Concept**				
		A	**B**	**C**	**D**	**E**
Reasonably priced	0	+	0	0	0	0
Ease of operation	0	0	0	0	+	+
Convenience of Use	0	0	0	+	+	0
Safety of Use	0	-	-	0	0	0
Net production quality	0	-	-	-	0	+
The efficiency of scattered rice is relatively small	0	-	-	-	-	+
High Productivity	0	0	0	0	+	+
Endurance	0	0	0	0	+	0
Ease of Maintenance	0	0	0	0	+	0
Total +		1	0	1	5	4
Total 0		5	6	7	3	5
Total -		3	3	1	1	0
Net Value		-2	-3	0	0	4
Ranking		4	5	3	1	1
Continue		NO	NO	NO	Yes	Yes

The concept assessment stage is used to emphasize the differences between the concepts to be compared. At this stage,weighting is carried out on the relative importance of the selection criteria and the focus is on a more thorough comparison of each criterion. At this stage a rating scale is alsodetermined which will be used in determining the weight scoreof each selection criterion. The rating scale is determined from1 to 5. The score of each concept is determined by adding up each weighted score of each criterion. The concept that has thehighest score is the concept that deserves to be continued in thedevelopment process. The concept assessment matrix can be seen in Table 3 below:

Table 3 Concept Screening Matrix

Concept Criteria	**Weight**	**Design Concept**			
		Concept (D)		**Concept (E)**	
		Rating	**Weight Value**	**Rating**	**Wight Value**
Reasonably priced	6,5	3,0	0,195	3,0	0,195
Ease of operation	7,5	4,0	0,3	4,0	0,3
Convenience of Use	8,5	4,0	0,3	3,0	0,255
Safety of Use	10	3,0	0,3	3,0	0,3
Net production quality	17,5	3,0	0,525	4,0	0,7
The efficiency of scattered rice is relatively small	20,5	2,0	0,41	5,0	1,025
High Productivity	14	4,0	0,56	4,0	0,56
Endurance	10	4,0	0,4	3,0	0,3
Ease of Maintenance	6,5	4,0	0,22	3,0	0,165
Total Score			3,25		3,635
Ranking			2		1
Continue			NO		Yes

3.2 Tool Design A semi-automatic

A semi-automatic rice thresher machine is a machine designed to separate rice from its panicles automatically by using a variety of threshing blades and a conveyor blower . The rice thresher design results can be seen in the image below.

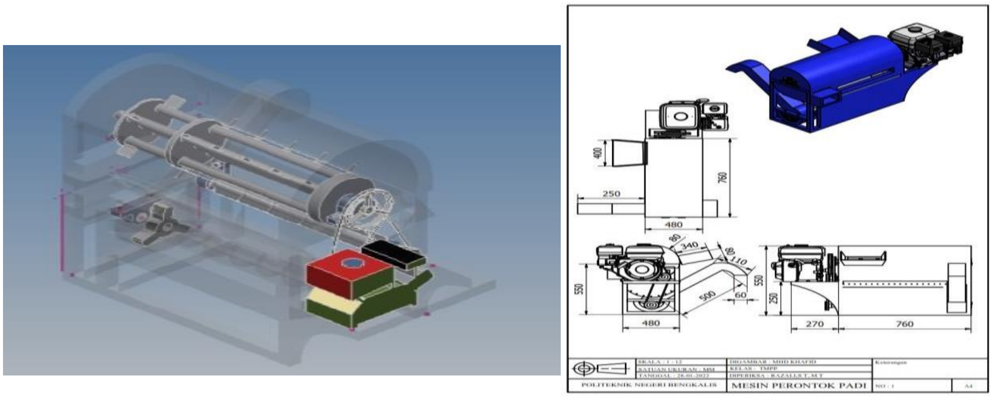

Fig. 2 Rice Thresher Machine

Source: personal documents ofTim Mhd Khafid and Razali

3.3 Crew Conveyor Component Design

Screw conveyor theoretical volume capacity.

$Qt = \pi 4\ x($ Du2 – du2) x Lp xns
Where Qt= screw conveyor volume capacity (cm3.minute-1); Du= thread diameter (cm); dp= shaft diameter (cm); Lp= pitchlength (cm); ns= screw rotation speed (rpm).

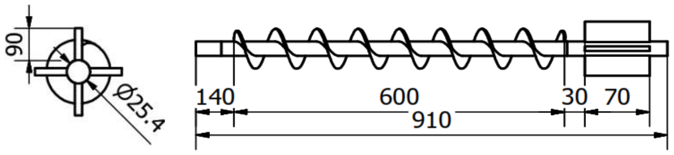

Fig 3. Screw conveyor 251 kg/minute
Source: personal documents of Mhd Khafid and Razali

Table 4. Component names and sizes

No.	Component Name	Size
1.	Frame Length	76 cm
2	Frame Width	48 cm
3	Frame Height	61 cm
4	Capacity	30 kg/10 minutes
5	Threshing speed	5kg/37,13 second
6	Thresher shaft speed	1040 rpm
7	Drive motor power	7,5 HP
8	shaft diameter	1 inch
9	Conveyor diameters	75 mm
10	Blower fan diameter	90 mm
11	Diameter of pulley A	304 mm
12	Diameter of Pulley B	250 mm
13	C pulley diameter	76 mm
14	The number of threshing blades	40 buah
15	Conveyor pipe diameter	110 mm
16	Diameter of fan panicle	310 mm
17	Bearings seated 205	1 inch
18	V-belts	A-58

3.4 Tool Performance Test

The modified rice thresher machinecan be used to thresh harvested rice with a bottom cut or top cut harvesting system. Threshing of rice is done by insertingthe whole stalk of straw into the thresher cylinder (throw- in).

1. Testing Materials

As is well known, the test material for this tool is rice that hasturned yellow and is ready to be harvested and then cut fromthe stem.

Fig 4. Straw Threshing and Weighing Process
Source: personaldocuments of Mhd Khafid and Razali

2. Threshing process

Fig 5. Rice Threshing Process
Source: personal documents of Mhd Khafid and Razali

3. Engine Performance Test Results

Testing the performance of the rice threshing machine was carried out in the rice fields belonging to the farmers. The measurement results are shown in the table below:

Table. 5 First Test

No.	**Initial Material Wight**	**Engine speed (Rpm)**	**Threshing time (Second)**	**Rice produced**	**Photo Quality of Rice hygine 92%**
1.	5	3110	33	3,0	
2.	5	3110	32	3,0	
3.	5	3110	34	2,9	
4.	5	3110	33	3,1	
5.	5	3110	31	3,0	
AVERAGE			32,6	3,0	

Table 6. Second Test

No.	**Initial Material Wight**	**Engine speed (Rpm)**	**Threshing time (Second)**	**Rice produced**	**Photo Quality of Rice hygine 92%**
1.	5	3110	47	3,2	
2.	5	3110	50	3,0	
3.	5	3110	47	2,9	
4.	5	3110	46	3,0	
5.	5	3110	44	3,0	
AVERAGE			46,8	3,02	

Table 7. Third Test

No.	**Initial Material Wight**	**Engine speed (Rpm)**	**Threshing time (Second)**	**Rice produced**	**Photo Quality of Rice hygine 92%**
1.	5	3099	55	3,2	
2.	5	3099	50	3,0	
3.	5	3099	47	3,1	
4.	5	3099	52	3,1	
5.	5	3099	47	2,9	
AVERAGE			50,2	3,02	

Table 8. Average 5 Kg Straw threshing time

No.	**Engine Rotation (Rpm)**	**Average Threshing time (Seconds)**	**Produced Rice (Kg)**	**Paddy Clean Quality (%)**
1.	3939	32,6	3,0	92
2.	3110	46,8	3,02	98
3.	3099	50,2	3,02	95
Total Average Performance of the Tool		**43,2**	**3,01**	**95**
Rice Thresher Capcity			$K = Bgr/T \times 3600$ **= 251 kg/jam**	

The results of testing the performance of the rice threshing machine for threshing rice with a screw conveyor and blower system is the level of cleanliness of the threshing grain, which is 95%. Meanwhile, the working capacity of the rice thresher reaches 251 kg of rice/hour (straw input capacity is 416 kg/hour). When compared with the working capacity of a comparison rice thresher (drawings of the reference machine concept) using the same gasoline engine power (the average thresher working capacity is 146 kg/hour and the highest quality level of grain cleanliness produced is 91.9%). So there is an increase in the working capacity of the rice thresher by 58%. While the increase in the quality of rice cleaning is 3.1% compared to the reference rice thresher.

Table 9. Performance of Rice Thresher Machines

Test Parameters	**Units**	**Value**
Straw Length (top cut)	Cm	48
Straw water content	%	65
Grain water content	%	23,5
Drive motor rotation		
- No burden	rpm	3110
- With a load	rpm	2985
Threshing cylinder rotation		
- No burden	rpm	1640
- With a load	rpm	1550
Cleaning fan rotation		
- No burden	rpm	2127
- With a load	rpm	2035
Conveyor and blower cylinder		
- No burden	rpm	2699
- With a load	rpm	2612
Treshing Capcity	Kg/jam	251
Straw input capacity	Kg/jam	416
Cleanliness level of rice	%	95

4 Conclusion

Based on the calculation results obtained by the average threshing of rice with 5 trials, the following conclusions can be drawn as The working capacity of the rice thresher reaches 251 kg of rice/hour (416 kg/hour straw input capacity). When compared with the working capacity of a comparative rice thresher machine (from the concept drawing of the reference machine) which uses the same petrol engine power, namely (average working capacity of the thresher 146 kg/hour), then there is an increase in the working capacity of the rice thresher made by 58%. The results of testing the performance of the rice threshing machine for threshing rice with a screw conveyor and blower system is the level of cleanliness of the threshing grain, which is 95%. When compared with the percentage of cleanliness produced by the Reference comparison engine, it is only 91.9%. So the increase in rice cleaning quality is 3.1% compared to the reference rice thresher.

References

[1] Tahir, A. (2022). Perancangan Mesin Perontok Padi Dengan SumberEnergi Surya. AL Jazair: Jurnal Ilmiah Teknik Mesin, 6(2)

[2] Putra, A. (2019). Rancang Bangun Mesin Perontok Padi Otomatis Berbasis Microkontroler. Kumpulan Karya Ilmiah Mahasiswa Fakultas sains dan Tekhnologi, 1(1), 78-78.

[3] Rahtika, I. P. G. S., Gunung, I. N., Mulawarman, A. A. N. B., Sastrawan, I. N., & Raditya, B. (2021). Rancang Bangun Mesin Perontok Padibertenaga Matahari Yang Ramah Lingkungan . Journal of Applied Mechanical Engineering and Green Technology, 2(1), 26-30.

[4] Habibu Rrohman, H., Rahman Saputra, R., & Silvy Aprilia, S. (2021).Rancang Bangun Mesin Perontok Padi (Doctoral dissertation, Politeknik Manufaktur Negeri Bangka Belitung).

[5] Wandana, M. D., & Hendri, H. (2020). Rancang Bangun Alat Perontok Gabah Berbasis Mikrokontroler mega 8535. JTEV (Jurnal Teknik Elektro danVokasional), 6(1), 306-321.

[6] Ibrahim, B., & Fadli, A. (2021). Perancangan Ulang Mesin Perontokan Padi Portebel. J. Peranc. Manufaktur, 2(1), 1-6.

[7] Kurnia, M. R. (2019). Rancang Bangun Sistem Filterisasi Pada MesinPerontokan Padi Otomatis Berbasis Mikro Kontroler. Kumpulan Karya IlmiahMahasiswa Fakultas sains dan Tekhnologi, 1(1), 96-96.

[8] rifin, S., Hersyamsi, H., & Tunggal, T. (2019). Modifikasi Unit Pencacah Pada Alat Perontokan Padi (Power Thresher) Menjadi Alat PencacahJerami (Doctoral dissertation, Sriwijaya University)

[10] Hermawan, M. V., & Nagoro, I. H. A. (2021). Pemanfaatan Mesin Perontok Padi Mini Berpengerak Motor Bakar Sebagai Alat Bantu Panen Padi,
Wonokerto, Wonogiri. Abdi Masya, 1(2), 58-65

[11] Maulana, B. (2021). Perancangan Kerangka Mesin Pemanenan Padi Simpel Harvester Berbantu Perangkat Lunak Solidworks 2016 (Doctoral dissertation, DIII Teknik mesin Politeknik Harapan Bersama).