International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Maize Threshing and Grinding

Dr. Vivekanand B Hudda[1], Dimple Tandon[2], Richard Paul[3], Venu Gopal M[4], M Shravan Kumar[5]

[1] Professor of Mechanical Engineering, MVJ College of Engineering, India.
[2,3,4,5] Student of Mechanical Engineering, MVJ College of Engineering, India.

ABSTRACT

Maize threshing and grinding remove the maize kernels from corn cobs. This multipurpose device is well-liked by small-scale farmers. It is portable and simple to use. The current state of the machine indicates that mass production can be accomplished in a short period of time. It is an ability to perform simultaneous operations like threshing and grinding individually and both combined as well. The problem here was removing the grain from the cob, which has always been a difficult task for the rural farmers who practise subsistence farming. The main aim was to design the best method for threshing and grinding operations and to improve the mobility of machines and mechanisms. The result obtained was for 3kg of corn and 2.8 kg of kernels obtained in 32 seconds of time, and for the grinding operation, it took 42 seconds of time. With a lower amount of moisture content in kernels, you can achieve a higher rate of output.

Keywords: Thresher, machine.

1. INTRODUCTION

Food is the basic commodity for human survival, and maize is one of the usual cereals consumed by people who are living in remote and elevated areas where the source of water is limited, which makes it difficult to propagate rice. Compared to rice, maize can grow with a minimal amount of water and does not require a thorough cleaning to get rid of weeds and other wild plants that compete for nutrients. It can also withstand high temperatures, which makes it more favourable for adjusting to the effects of climate change. It is useful as a raw material in the food industry. A large proportion of processed maize is consumed fresh. The production of maize is quick, easy, cheap, and economical as compared with other food crops, including palm trees and cocoa, which may take several months to reach maturity. Processed maize is used in the manufacturing of many products A threshing machine, or thresher, is a piece of farm equipment that threshes grain—that is, it removes the seeds from the stalks and husks. It does so by hammering the corn to make the seeds fall out Maize is a versatile crop that can be used for human consumption, animal feed, and industrial purposes such as biofuels and bioplastics. Additionally, the use of threshing machines has greatly increased the efficiency of maize production, allowing for larger yields and reduced labour costs. A "corn thresher refers to a mechanical device for threshing corn. A mechanical corn threshing tool is referred to as a "corn thresher." High automation, strong safety, easy operation, and low energy consumption are all features of the maize thresher. The corn cob is first peeled and then threshed in the inner portion of the corn sheller, which is an up-down structure. This has resulted in a sharp rise in the production of maize in many countries, making it a more affordable and accessible crop for both farmers and consumers. Moreover, the use of corn threshers has also helped to reduce post-harvest losses and improve the quality of maize grains by removing Impurities and preserving their nutritional value.

2. Description of the Machine

This maize thresher was created to accommodate the daily requirements of independent farmers or small-scale farmers for domestic or commercial use. When connected to a moving vehicle, the equipment, which has tyres, can be driven from one agricultural location to another. Moving from one place to another without using heavy lifting equipment is premature. The maize thresher is made to be user-friendly and simple to use, so even farmers with little technical expertise can use it. Greater flexibility in terms of where and when it can be used is also made possible by its mobility. Additionally, it is less expensive than imported threshers, which are very expensive and out of the reach of the majority of farmers in rural areas. Combine harvesters, pickers, or other foreign threshers are a few examples of imported threshers. The maize thresher is thus an affordable and useful option for small-scale farmers who need to thresh their crops without spending a lot of money on expensive machinery or depending on manual labour. It increases the farming process' efficiency, which results in higher yields and greater profits in addition to saving time and effort.

3. Materials Selection

This maize thresher was created to satisfy the needs of independent or small-scale farmers who hire it on a daily basis for business purposes. The equipment has tyres and may be driven from one agricultural place to another when coupled to a moving vehicle. It is early to move from one place to another without any heavy lifting equipment. It is also of low cost when compared with imported threshers like combine harvesters, pickers, or other foreign threshers, which are very expensive and beyond the financial capacity of rural farmers.

4. Design Consideration

a) Threshing

This machine's design is based on two principles:

- The gravitational falling of the entire corn via the hopper to the revolving beaters and the exit of the grains to the receiver.
- The impact force applied to the whole corn by the revolving beaters, as well as the motion of this whole corn down the length of the shelling drum. the cylinder drum is 350mm*800mm in size, with a hopper of 550mm*125mm*340mm and a hopper plate of 550mm*130mm. This type of design increases shelling efficiency and corn seed quality. The immatureness of the corn kernels or the high moisture content of the corn ears may cause corn ears to stay un threshed in this type of arrangement.

b) Grinding

This machine's design is based on two principles:

- The gravitational fall of the entire corn kernels via the grinding tray to the revolving hammers and the exit of the grains to the rotatory hammer
- The frictional force applied to the whole maize by the revolving hammer as well as the motion of the whole maize kernels break them into small, tiny particles, which are dissipated out through the perforated sheets.
- The door slotting is 650mm*130mm, the grinding body diameter is 310 mm, the grinding exhaust is 400mm*90mm, and the grinder shaft length is 530mm. This type of design increases grinding efficiency.

5. Design Calculation

5.1 Threshing bar Design

Weight of the threshing bar,

$$w = mg \qquad (1)$$

Where, m = mass of the threshing bar, g = acceleration due to gravity. The mass of the threshing bar,

$$m = \rho V \qquad (2)$$

Where, ρ = density of the threshing bar material, V = volume of the threshing bar. Volume of the threshing bar,

$$V = \pi r 2\, l \qquad (3)$$

Where, r = radius of the threshing bar, l = length of the threshing bar.

5.2 Shaft Design

Shaft design consist primarily the determination of the correct shaft diameter to ensure satisfactory strength and rigidity when the shaft is transmitting power under operating and loading conditions. Therefore, in other to safeguard against bending and tensional stresses, the diameter of the shaft was determined from the equation.

$$d\text{^}3 = (16T\_e)/(\pi\tau\_s\ )$$

$$Te = \sqrt{}(MKm)\ 2 + (TKt)\ 2$$

Where: d = Shaft diameter (m).

Te = Equivalent twisting and bending moment (Nm).

τs = Allowable combine shear stress for bending and torsion (N/m2).

Km = Combined shock and fatigue factor applied to bending moment and for rotating shaft loaded gradually the value is between 1.5 to 2.0.

Kt = Combined shock and fatigue factor applied to torsional moment for a shaft loaded gradually, the value ranges is between 1.0 to 1.5.

M = Maximum bending moment (Nm).

T = Torsional moment (Nm).

Ss = Allowable stress and for shafts without keyway the value is 55 MN/mm2

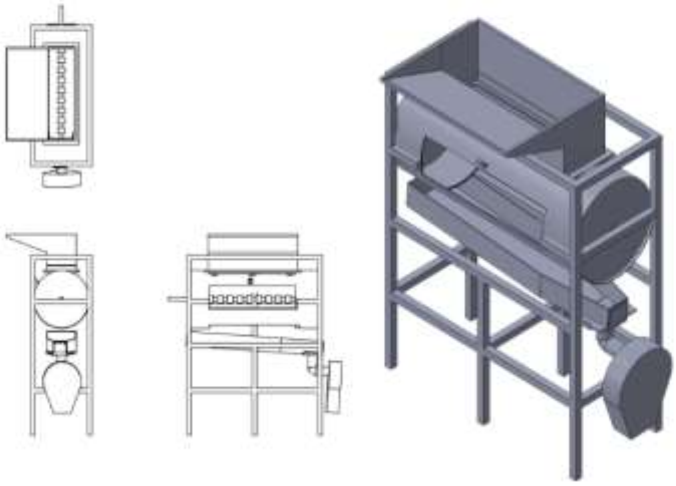

FIG: 5.2 Shaft Design

Figure 5.2 shows the shaft of this machine has 15 beaters arranged longitudinally in six rows welded to it and a pulley mounted on it. It is supported by bearings. To ensure adequate strength and rigidity when the shaft is transmitting power under various operating and loading conditions, shaft design primarily entails determining the proper shaft diameter. Shafts are solid. The following presentation is based on shafts of ductile materials and circular cross-sections. The length of the shaft has been predetermined.

5.3 Threshing Force

Threshing force, which is the force that separates a maize from the cob has a great importance in evaluating losses over design and application of harvesting and threshing machines.

The force F required to thresh the maize along the length of the threshing bar is given by

$$F = m\omega^2 r \qquad (4)$$

Where m is mass of threshing bars, ω is the angular velocity of shaft. r = arm of the threshing bar

The angular velocity ω is determined by the equation:

$$\omega = 2\pi N / 60 \qquad (5)$$

Where N is the speed of threshing which is in revolutions per minute

5.4 Threshing Torque

The torque, T, is given by:

$$T = F \times r \qquad (6)$$

Where, F = threshing force; r = threshing arm

5.5 Power Delivered by Shaft

Shaft power is the mechanical force that the propeller hub receives from the propeller shaft. It results from multiplying the shaft torque by the speed at which the shaft rotates. The total power transmitted to all propeller shafts in the case of multiple propeller shafts is the shaft power. The shaft delivers power P along the length of the given threshing bars.

$$P = T\omega \qquad (7)$$

where: ω = angular velocity (rad/s);

T = threshing Torque (Nm).

5.6 Torsional Moment, MT

A twisting force applied along the body's transverse axis causes a moment known as a torsional moment. In contrast to forces along the axis, which produce homogeneous stress over the body's cross-section, twisting forces produce torsional stress.

The torsional moment, MT, is given by:

$$MT = \propto f \sin\theta \qquad (8)$$

5.7 Belt Selection Appropriate

Belt selection will assist in effective power transmission. A belt provides a convenient mean of transferring power from one shaft to another. The effective pull on a belt is given by:

$$T = (T1 - T2)$$

Where T1 is tension on tight-side, and T2 is tension on slack slide.

But $$T\_1/T\_2 = exp(\mu\theta cosec\beta)$$

Where β is the grove semi-angle, θ is the angle of lap or angle of contact at the smaller pulley, and μ is the coefficient of friction, 2β is the angle of the groove =300. The μ of friction for rubber belt on cast iron or steel operating on dry surface is

μ = 0.3. β= 15, θ = π/2 = 3.142/2 = 1.571

5.8 Weight of the Pulley

The weight or effort force experienced by the end of a pulley system when raising an object of specified mass at a constant speed is known as the pulley weight.

The weight of the pulley on the shaft is given as:

$$\text{m} = \rho v \qquad (9)$$

Where m is the mass of the pulley, ρ is the density of the pulley material and v is the volume of the pulley. Weight is mass multiplied by acceleration due to gravity (g).

$$w\_p\ (weight\ of\ pulley) = \rho \times ((\pi D\hat{}2)/4) \times t\_p \times g \qquad (10)$$

Where d is diameter of pulley, tp is the thickness of the pulley. D is the diameter of the driven pulley

5.9 The power transmitted by belt

A thin, inextensible band that crosses two pulleys to transfer power from one shaft to another is the fundamental purpose of belt drives. These pulleys can rotate either at a constant speed or at various speeds. The driven pulley receives mechanical energy from the driving pulley in the form of rotating motion. Belt transmission power is provided by

$$P = (T1 - T2)v \qquad (11)$$

But $velocity$,

$$v = \pi dN/60 \qquad (12)$$

Where, d is the diameter of the shaft

5.10 Parameters Detials.

The parameters for creating a maize threshing and grinding machine are shown in Table 1 below. The machine's size, weight, power source, and capacity are among the parameters. The machine must meet these specifications to ensure that it performs and operates efficiently, and Table 2 shows the overall dimensions in SI units.

S/N	TYPE	SYMBOL	VALUE
1	Threshing bar weight	W	0.735 N
2	Angular velocity Threshing Grinding	ω ω	150.816 rad/sec 293.25 rad/sec
3	Threshing arm	R	0.1 m
4	Threshing Force	F	221.6 N/M
5	Grinding Force	F	838.45 N/M
5	Threshing Torque	T	28.82 N/M
6	Power delivered Threshing Grinding	P P	4346.517 W 31963.6635 W
7	S.I Engine Threshing Motor Grinding Motor		2hp 5hp
8	Pulley Weight Threshing Grinding	WP WP	0.637 Kg 0.443 Kg
9	Torsional moment	Mt	18.55 N/M
10	Threshing Tension in tight side Tension on slack slide	T1 T2	1849 N 11544 N
11	Grinding Tension in tight side Tension on slack slide	T1 T2	1975 N 1233 N
12	Belt Type Threshing Grinding		B56 Dual

Table 5.10.1:

Calculated values for maize thresher and grinder

S/N	Type	Value
1	Hopper	550mm*125mm*340mm
2	Hopper Plate	550mm*130mm
3	Drum	350*800mm
5	No of chain	14mm*13mm
6	Distance B/W two chain and bushes	40mm
7	Length of the chain	130mm
8	Chain Thickness	5mm
9	Bearings	UCT206-30mm
10	Thrusher Belt	B56
11	Belt size	38mm
12	Motor Specfication : Thrushing Motor	2hp motor,3phase,1440 rpm
13	Feeder Tray Width	540mm*400mm 190mm
14	Hammer length Hammer Width Hammer Thickness Hammer inner Dia	90mm 80mm 12mm 260mm
15	Blade Holder Plate	140mm in dia
16	Door slotting	650mm*130mm
17	Grinder Body Dia	310mm
18	Grinder Belt	Dual
19	Grinder Exhaust	400mm*90mm
20	Grinder Shaft Length	530mm
21	Grinder motor pulley Dia Shaft Dia	1 pulley 125mm 75mm in dia 35mm
22	Motor Specification: Grinding Motor	5hp motor, 3 phase, 2800 rpm.
23	Frame dimension: Length Width Height	1220mm 600mm 1000mm

Table 5.10.2:

Maize thresher and grinder design parameters

5.11 Machine Fabrication Processes

The construction process involves cutting, shearing, drilling, welding, grinding, polishing, assembling, and spraying These steps are crucial in ensuring that the final product meets the required specifications and quality standards. Additionally, the use of advanced technology and skilled labour helps streamline the construction process and minimise errors. These steps are necessary to create a finished product that meets the required specifications and standards Each step in the construction process requires specialised skills and equipment to ensure that the final product is of high quality and durability. Additionally, strict quality control measures are implemented throughout the process to guarantee that the finished product meets all safety and performance standards. The quality of the final product is dependent on the skill and precision of each step in the construction process Therefore, it is crucial to have a team of experienced professionals who can execute each step with precision and attention to detail. Proper planning and coordination among team members are also essential to ensuring that the construction process runs smoothly and efficiently.

Fig 5.11.1: Hopper

Fig 5.11.2: Controlling Plate

Fig 5.11.3: Safety doors

Fig 5.11.4: Bush and chain attached to the shaft

Fig 5.11.5: Blades attached to the hub

Fig 5.11.6: Pulley and Shaft

Fig 5.11.7: Drum

Fig. The hopper is only intended to be fed vertically, according to 5.11.1. Mild steel sheet metal was used for construction because it is widely available and reasonably priced. The hopper is shaped like the frustum of a pyramid that has been cut off at the top, with rectangular shapes at the top and bottom. This shape minimises the risk of blockages by allowing for simple and effective material flow. The hopper structure is also stabilised by the rectangular shapes at the top and bottom. Fig. 5.11.3: This design feature ensures that the hopper can be safely accessed and maintained without compromising the structural integrity of the equipment. The safety door is also positioned so that it can be used in any emergency, such as explosions or fires. The hopper's rectangular shape also facilitates installation and system integration. The door might be made of steel. Fig. In accordance with 5.11.4, a bush is a tool with bristles that are typically attached to a handle and are used specifically for sweeping, smoothing, scrubbing, or painting. Fig. A chain is a collection of linked objects that are typically made of metal. There may be two or more links in a chain. There are many different ways to categorise chains. Theoretically, a chain is a continuous, flexible rack that engages a set of gears' teeth. There may be brackets for the blades to slide into and be firmly fastened, or they may be bolted flat to the hub plate. Fig. 5.11.6: A pulley is a wheel with a flexible rope, cord, cable, chain, or belt mounted on the outside of the wheel. For the transmission of energy and motion, pulleys can be used alone or in conjunction. Sheaves, or pulleys with grooved rims, are frequently used in machines to lift heavy objects more easily. They operate on the idea that by evenly distributing the load's weight across several ropes or cables, less force is needed to lift the load. Fig. According to 5.11.7, the threshing drum is the thresher's most important component. This element induces the crop to release grains or seeds. The crop is beaten against the concave to achieve this action. It is important to note that the speed of the threshing drum should be adjusted depending on the type of crop being harvested. The speed of the thresher is determined by the pulley of the thresher with respect to the diameter of the drive motor or engine. The threshing drum should also be maintained and cleaned on a regular basis to ensure effective operation and increase its lifespan.

6.Testing and Evaluation

6.1. Testing

After the assembling was completed the machine set for one free trial without any loads to ensure the fittings. The samples were collected and loaded in the hopper. The whole undamaged maize Whole undamaged corn with cobs were selected and weighed in batches of 1kg. Some samples were collected and used to determine the moisture content of the corn. Samples of weight 1kg, 3.2 g and 5kg were fed into the machine and feed time recorded. The shelled Maize was collected through the exit chute and the cobs also collected through the feeder tray. The collected shelled corn and the cobs were weighed and the weights recorded. The experiment was repeated twice and average values noted

6.2 Performance analysis

- **Threshing**

The throughput capacity: the actual throughput capacity and the mechanical efficiency were determined. Maize cobs weighing 1, 3.2, and 5 kg were measured using a weighing scale. A cob was loaded at a time into the hopper. The time it takes to load and finish threshing. The total weights of broken or damaged grain, cob weight, and percentage mechanical damage were calculated.

- **Grinding**

The through-out capacity and the mechanical efficiency were determined for maize grinding of 1 kg -950gms, 2kg - 800gms and 4kg -200gms respectively were measured with weighing scale . The maize kernels were loaded at a time into the grinding. The total weight of the grinding grains was determined. The total weight of the broken or damaged grain is the weight of the kernels percentage and mechanical damage were determined.

Weight of corn	Threshing time	Grinding time
1kg	13sec	25sec
3.2kg	32sec	42sec
5kg	52sec	63sec

Table 6.2.1: Data obtained from designed machine test

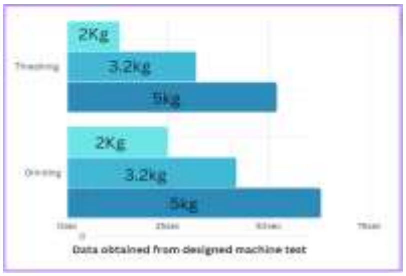

Fig 6.2.2: Bar Graph

6.3 Testing for individual and combined process

Figure 6.3.1 illustrates the individual process for 3.2 kg of maize, with a threshing time of 32 seconds, a weight of 2 kg for the obtained kernels, and a damage percentage of only 10%. The final output is 1.9 kg after 42 seconds of grinding. Here are the outcomes of the lab experiment.

Individual Processes		
SN	DESCRIPTION	QUANTITY
Threshing Process		
1	Weight of maize cobs before threshing	3.2 kg
2	Time taken for threshing	32 sec
3	Capacity	360 kg/hour
4	Weight of maize seeds after threshing	2.00 kg
5	Percentage of damage after threshing	10%
Grinding Process		
1	Feed to grinding machine	3.5 kg
2	Grinding time	42 sec
3	Capacity	300 kg/hour
4	Weight of the output	1.995 kg

Table 6.3.1: Testing for Individual process

Figure 6.3.2 depicts the entire procedure. If we use 3.5 kg of maize, the process will take 52 seconds, yielding a final output of 3.00 kg. This represents the outcomes of the lab experiment. The outcomes show that the method is effective in turning the initial quantity of corn into a final output of 3 kg in a relatively quick 52 second operation. To enhance the procedure and increase its scaleability for industrial applications, additional testing and optimisation may be required.

Complete Process		
SN	DESCRIPTION	QUANTITY
1	Weight of maize cobs before threshing	3.5 kg
2	Time taken for threshing	42 sec
3	Capacity	300 kg/hour

Table 6.3.2: Testing for combined process

7. Bill for Engineering Measurement and Evaluation

SL.NO	PARTICULARS	QTY	RATE	PRICE
1	CORN CRUSHING AND GRINDING MACHINE FABRICATION AND ASSEMBLY • M.S FRAME WITH POWDER COATING • S.S TANK WITH HOPPER (304 GRADE) • S.S TRAY (304 GRADE) • 1 HP GEAR MOTOR • GRINDER ASSEMBLY • CRUSHER ASSEMBLY	1N	98,000/-	98,000/-

Table 7.1: (BEME)

The bill for engineering measurement and evaluation is shown in **Table 7.1**. The table includes the breakdown of all the materials and labour required for the engineering measurement and evaluation project. It provides a clear understanding of the expenses involved in the project This information can be used to create a budget for the project and ensure that all expenses are accounted for. It can also be helpful in identifying areas where cost savings can be made without compromising the quality of the project.

8. CONCLUSION

The maize threshing and grinding machine was designed, fabricated, and tested. The specific objectives of the work are to design, fabricate, and evaluate the performance of a motorised maize thresher. The obtained results demonstrated that the machine performed well at low moisture contents. The study also revealed that the machine was efficient in terms of time and labour savings compared to traditional methods. Further research can be conducted to improve the machine's performance at higher moisture contents.

1. The developed maize thresher and grinder have higher output and grinding efficiency compared to some existing maize threshers. As a result, user labour productivity will rise, resulting in improved maize timeliness.
2. The highest average efficiency of the machine was 99.01 percent at 10 percent moisture content using 95 kg of maize as the feed rate, and the lowest average efficiency was 87.07 percent.
3. The dual purpose of threshing and grinding maize at the same time reduced the labour cost and time involved in the processing of maize This innovation in maize processing technology has the potential to greatly benefit small-scale farmers who rely on maize as a staple crop by increasing their productivity and reducing their workload. Additionally, the improved efficiency of the machine could lead to cost savings for farmers and consumers alike.
4. Because of its limitations, ease of operation, and high quality of ground maize, the machine is recommended to farmers and other maize processors.

References

1. Ugwu K. C Omoruyi A.Development and Performance Evaluation of Maize Threshing and Grinding Machine ,American Journal of Engineering Research (AJER) Volume-5, 2016,Issue-10, pp-24-29
2. Anirudha G. Darudkar, Dr. C. C. Handa Literature Review of Corn Sheller Machine, IJIRST –International Journal for Innovative Research in Science & Technology| Volume 2 | Issue 01 | June 2015
3. D.O Aremu ,I.O. Adewumi, J.A. Ijadunola, Design, Fabrication and Performance Evaluation of a Motorized maize shelling machine ,Journal of Biology, Agriculture and Healthcare, Vol.5, No.5, 2015

4. Praveen kiran malli ,DR. C. N. Sakhale ,S .D Shelare , A literature review on design and development of maize thresher, international journal of pure and applied research in engineering and technology , Volume 3 (9): 9-14,2015

5. Ignatio Madanhire, Simon Chinguwa Elton Ntini and Charles Mbohwa, Proceedings of the International Conference on Industrial Engineering and Operations ManagementToronto, Canada, October 23-25, 2019

6. Adeyi Abdulrasaq Mashood, Willoughby Fouad Ayinde, Shehu Muhammed Yusuf, Ola Olalekan Abiola and Faleye Tope, Performance Evaluation of a Maize Cob Thresher, Journal of Agricultural Science and Technology A 9 (2019) 66-72

7. Merga Workesa Dula, Review on Development and Performance Evaluation of Maize Sheller, International Journal of Engineering Research & Technology (IJERT) Vol. 8 Issue 05, May-2019

8. Kedar Patil, Shamuvuel Pandit , Gajendra Pol ,Sunil Kadam ,Avdhut Jadhav, Design and Fabrication of Corn Shelling and Threshing machine, International Journal of Innovative Research in Science, Engineering and Technology Vol. 5, Issue 7, July 2016

9. .N. Nwakairea ,B.O. Ugwuishiwub ,C.J.Ohagwuc, Designe , Construction and performance Analysis of a maize thresher for rural Dweller, Vol. 30, No. 2, June 2011.

10. K. A. Olaiya,I.O. Alabi, A.P. Okediji ,K.A. Ajibola and M.O. Kareem, Development of Motorized Corn Thresher, International Journal of Scientific & Engineering Research Volume 12, Issue 8, August-2021

11. Manoranjan Kumar, Sunil Kumar, Dheeraj Kumar and Priyanka Rani Impact Assessment of PAU Maize Dehuskar-Cum-Sheller with the Local Variety Devaki , International Journal of Current Microbiology and Applied Sciences, Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-7: 3526-3532