

DESIGN AND FABRICATION OF PORTABLE COCOA BEAN SEPARATION MACHINE

HARSHA R, prof. Pranod kumar N, Pavan V, Mahesh Raju S, Naveen Kumar S

ALVAS INSTITUTE OF ENGINEERING AND TECHNOLOGY

ABSTRACT

India is an agriculture based country and agriculture employs more than 50% of our country's population, hence agriculture is one of the main sources of income for our country. The main objective of this project is to help the small scale farmers exclusively working in the field of cocoa cultivation. As the farmers lack the advanced machines to process their cultivated cocoa fruit. Our project "design and fabrication of portable Cocoa bean separating machine" can greatly enhance the processing capabilities of cocoa fruits and promises the safety of farmers rather than outdated methods used for processing. This machine is simple in construction and compact, it can be manufactured from the parts which are effortlessly available. This machine is cost effective as the labour cost is almost reduced. This machine is highly productive and specifically designed to reduce the time taken for separation of cocoa beans as compared to traditional method. This machine can be owned by a group of cocoa farmers who can bear the low maintenance cost of this machine.

Keywords: *agriculture, cocoa pods, cocoa cultivation, machine design.*

INTRODUCTION

Cocoa tree thrives in hot and rainy tropical climates (20 degree north and south of the equator) and predominantly grows in Africa, Asia, Central and South America. Cocoa tree is a small (4 to 8 m height) evergreen tree. In India, it is mainly cultivated in Karnataka, Kerala, AndhraPradesh and Tamil Nadu mainly as intercrop with Arecanut and Coconut. Slowly the area under cultivation is being promoted by many chocolate producing companies as contract farming. In the survey conducted during the time period 2015-2016, India produced approximately about 17,200 metric tonnes.

The shell (husk) is a good source of potassium and can be used in the production of potash fertilizer, local soap, biogas, The beans are ground into powder for making beverages, chocolates, ice-cream, soft drinks, cakes, biscuits, flavouring agents and other products. Cocoa butter, made from the fat extracted from the beans, is a stable fat used in the production of cosmetics and pharmaceutical products.

This study outlines the design of a very efficient, highly productive, cost-effective, ergonomic and environmentally friendly cocoa splitting machine that will be used by cocoa Farmers world - wide to increase and boost productivity and enhance the quality of cocoa products to the highest possible level devoid of any hazards, dangers or perils. This machine can be manufactured from locally available scraps and assembled and maintained at a relatively low cost. Therefore it can be owned patronized by a group of cocoa farmers who can easily bear the low cost of maintenance of the already relative cheap machine.



Figure : Cocoa Pod

The cocoa fruit comprises of the pod or shell, beans or seeds, husk, placenta and mucilaginous pulp which contains a sweet juice referred to as '*sweating*'. Generally, cocoa pods are oval-shaped and vary in size. The length is normally between 20 and 32 cm. Its colour ranges from yellow or green to red or violet. The surface texture is warty and deep furrowed to nearly smooth in most cases. The husks appear appreciably in thickness. Each bean is surrounded by mucilaginous pulp. The number of beans per pod is usually between 30 and 40. Each bean consists of two convoluted cotyledons and is enclosed in the testa. The cotyledon has its colour varying from white to purple. Figure 1.1 shows the cocoa fruit, beans with the pulp, as well as the pod or the husk.

PROBLEMS EXISTING IN MANUAL METHOD:

Now a days there is no machine to do the process of cocoa pod cutting and cocoa bean separation rural farmers of cocoa farm hence this process is done manually.

So major disadvantages of existing method is that,

- Chance of injuries.

The cutting operation is done using knives, and there are many chances of getting injured. Also while separating the beans, penetration of the small cocoa pods particles between the nails and the skin leads to higher pain for the labourers.

- This method takes more time. It will take about 6 hours for a skilled labourer to cut and separate 100 kg of cocoa beans. So it is time consuming
- High Labour cost. For separating 100 kg of cocoa beans, it requires two labourers. One for cutting the cocoa pods and other for bean separation. So the labour Cost is high.
- Physical energy requirement is high.

CONSTRUCTION

BLOCK DIAGRAMS:

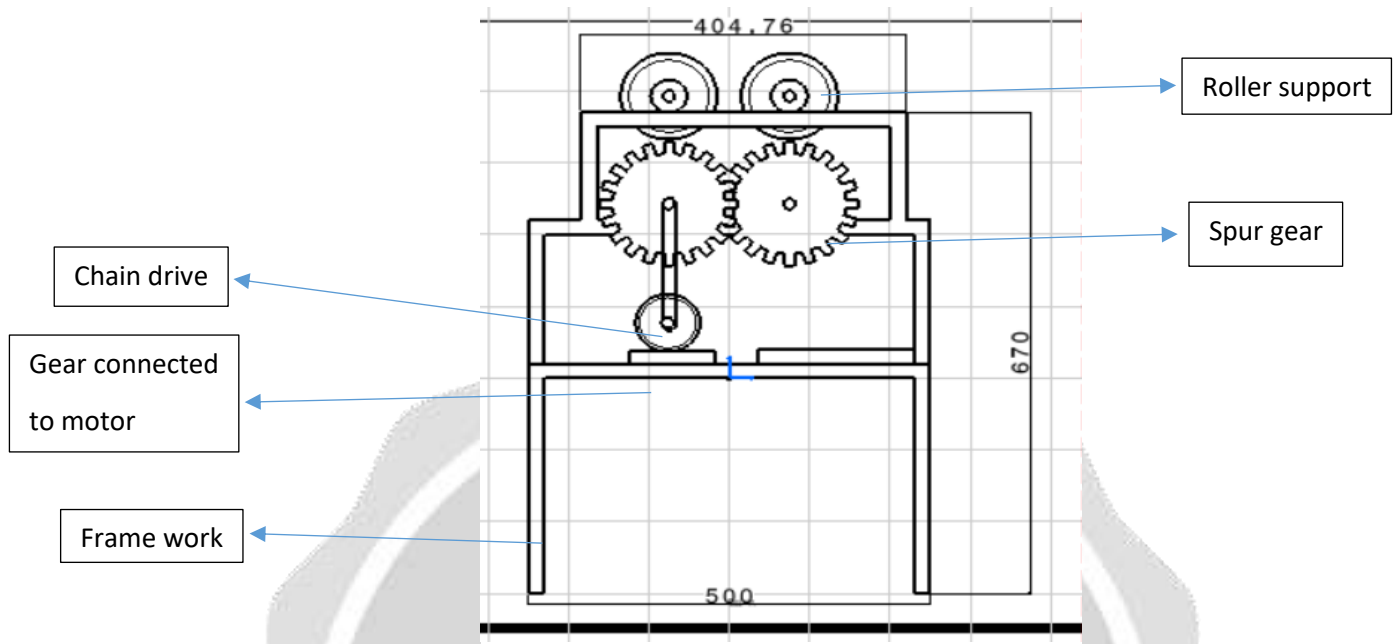


Figure: 2D Front View Of Machine

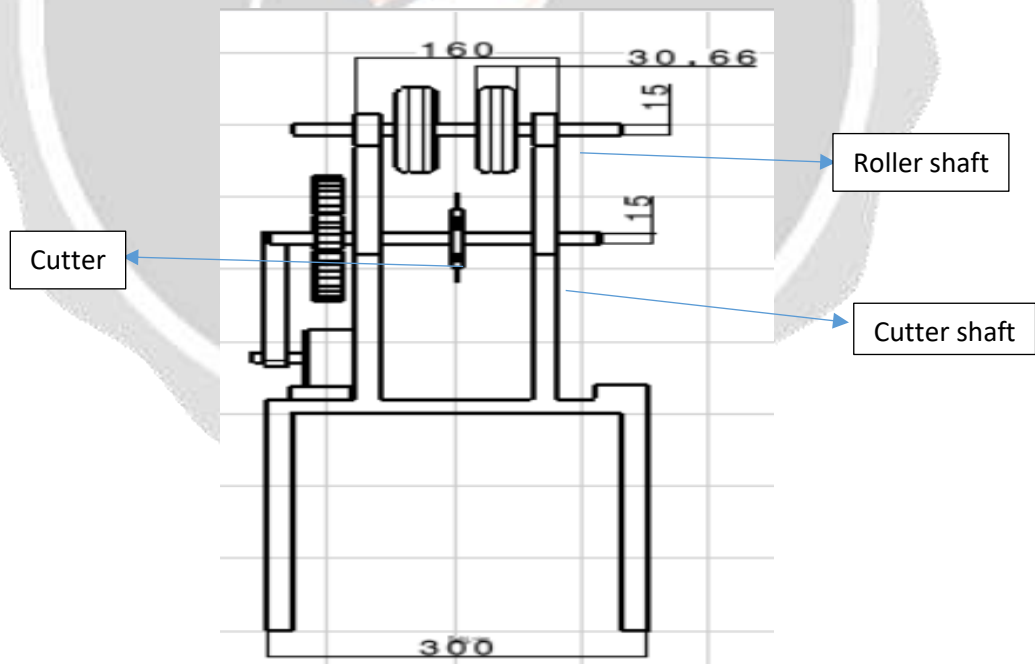


Figure : 2D Right View Of Machine.

All the dimensions are in mm.

CALCULATIONS

MOTOR CALCULATIONS:

TORQUE AND POWER REQUIREMENT:

Torque $T = F_c \times r$

Where,

$b =$ Breadth of the chain $= 0.015 \text{ m}$
 $t =$ Thickness $= 0.007 \text{ m}$
 $l =$ Length $= 1 \text{ m}$
 $\rho =$ Mass density $= 1140 \text{ kg/m}^3$

So,

$m = 0.1197 \text{ kg/m}$

Now,

$v = (3.14 \times d \times n) / 60$
 $= (3.14 \times 0.2286 \times 3000) / 60$
 $= 35.90 \text{ m/sec}$

$T_c = m \times v^2$
 $= 0.1197 \times (35.9)^2$
 $= 154.27 \text{ N}$

$F_c = T_c$

(Circumferential force on the motor is the centrifugal tension in the chain)

Now torque $= F_c \times \text{radius of sprocket in the motor}$
 $= 154.27 \times 0.1143$
 $= 17.633 \text{ N-m}$

POWER RATING OF THE MOTOR:

Torque at motor sprocket $= 17.633 \text{ N-m}$
 Torque at the reduction gear $= 5.289 \text{ N-m}$
 Power of the motor $= \text{Torque} \times (2 \times 3.14 \times N) / 60$
 $= (5.289 \times 2 \times 3.14 \times 1400) / 60$
 $= 775 \text{ Watts}$
 $= 775/745.7$
 $= 1.04 \text{ HP} = 1\text{HP}$

WORKING

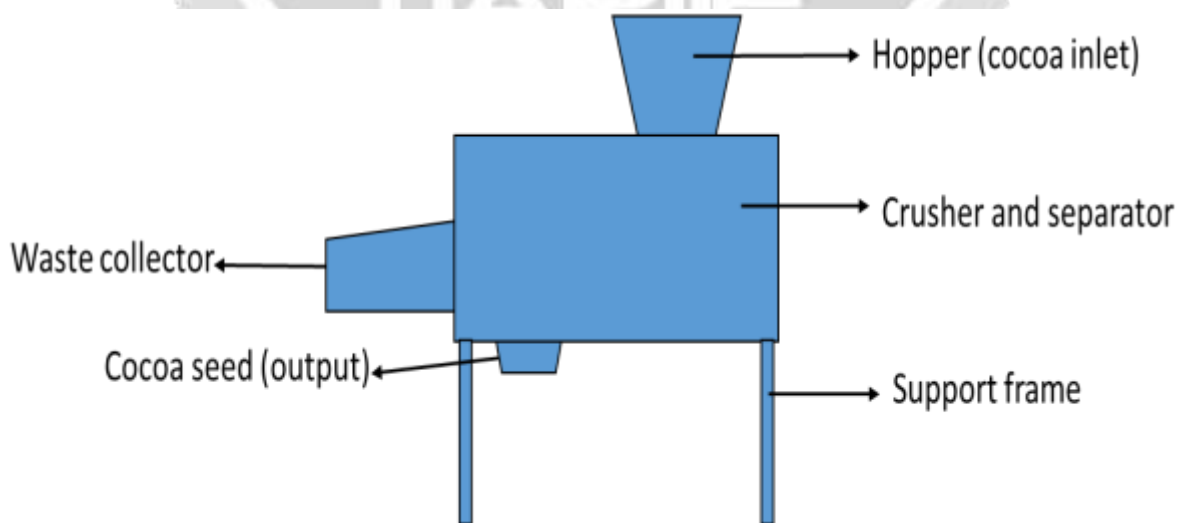


Figure : working Outline

The main objective of the machine is to cut the cocoa pods and to separate cocoa beans from cocoa pods automatically.

THIS MACHINE CONSISTS OF FOUR UNITS.

- **Input Unit (loading unit)**- Input unit consists of hopper and rubber roller, initially the cocoa pods are feed into the hopper the main purpose of the hopper is to make sure that the cocoa pods are feed into the machine vertically, because it is easier for the cutter blades to cut along the fibres of the pod, rather than perpendicular to the fibres hopper is also used for safety purpose so that human hands does not make contact with roller while loading the pods, rollers are run by electric motor, both the roller are mounted on shaft and one of the shaft is welded to a sprocket this roller is linked to motor by a chain which drives the roller. Rollers grip the pod with its rubber surface and pushes the pod down towards cutting blades.
- **Cutting Unit**- this unit consists of two cutter made of steel material rotating opposite to each other, with the help of spur gears which are driven by the electric motor, the cutter consists of seven sharp blades, when the pod is forced down by the roller the sharp blades cuts through the shell of the pod along the pods fibres, due to high speed rotation of blades the shell is ripped apart and the seeds inside the pod are exposed.
- **Rotating Unit (separating unit)** - the separating unit is made of metal cylinder mesh, which is driven by the electric motor with the help of cardan joint, the slit pods by the cutter are made to pass through this unit by the curved path provided by sheet metal, as the seeds inside are sticky the seed are separated by the rolling action of the mesh the pods inside mesh tumbles and the seeds are forced out of the pods, the separated seed falls through the mesh holes and since the pods are in bigger size they are collected at the end of the cylinder.
- **Collecting unit**- the split seeds from the cocoa pods are collected in a clean tray placed under the cylinder mesh and the waste empty pods are collected in another tray placed at the end of cylinder mesh.

RESULTS AND DISCUSSION

First we ran our machine dry without loading it with cocoa pods, to ensure that the working of the machine was proper. Further we conducted five test runs, in which a single cocoa pod was added for each test run.

The main purpose of this test run was to record the process time taken by the machine to harvest a single cocoa pod from start to the end, i.e. From splitting of cocoa pods to separating and collecting of cocoa beans.

The following observations were made during each test run

Table 7.1: Trail run result.

Trial number	Number of pods	Time taken in seconds
1	1	38
2	1	35
3	1	36
4	1	32.4
5	1	33
	Average time taken	34.88 = 35

From the above table we can conclude that the average time taken for the machine to process a single cocoa pod is 35 seconds, so for 10 minutes the number of cocoa pods processed is;

$$10 \text{ min} * 60 \text{ sec} = 600 \text{ secs}$$

$$\therefore 600 \text{ sec} / 35 \text{ sec} = 17.14 = \underline{17 \text{ pods}}$$

From the above obtained value we can say that for 10 minutes the number of cocoa beans processed is 17 cocoa pods, so for 1 hour (60 minutes) the machine can process around,

$$10 \text{ min} = 17 \text{ pods}; 1 \text{ hour} = 60 \text{ min}$$

$$17 * 6 = \underline{102 \text{ pods}}$$

So we can say that within 1 hour the machine can process around 102 cocoa pods.

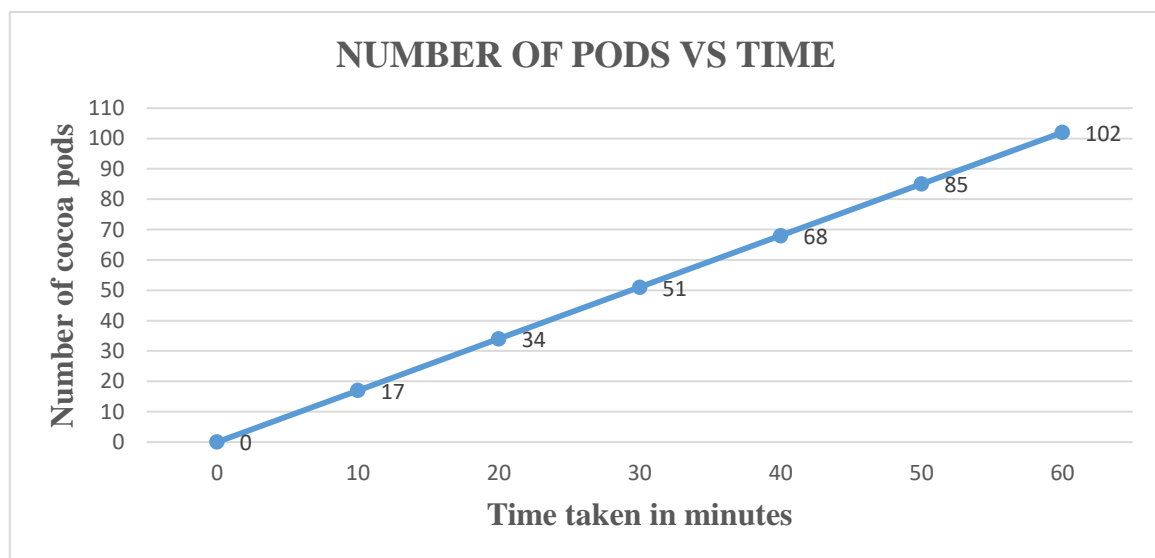


Figure 7: graph.

An average cocoa pod weighs around 400 grams, so the total weight accounting for 102 cocoa pods is 40.8 kgs. With the above data we can say that within 1 hour the machine can process approximately 40.8 kilograms.

CONCLUSION

Our project "Portable Cocoa Bean Separation Machine" is designed and by using locally available and easily accessible material and components such as cutter and framework was simple enough to be easily fabricated. This machine working is simple enough to be understood by a framer with bare minimum knowledge, the maintenance of this machine is regular lubrication, and in case of repairs the parts can be easily replaced.

Using our machine the farmers work such as traditional method employed for cocoa pod splitting and bean extraction can be reduced to some extent. The entire design is automatically operated which will be helpful for small land farmers. This project consumes less time and saves the money. With this Portable Cocoa Bean Separation Machine, farmer can cover more amount of fruit than manual method. This project also highly ergonomic, environmentally friendly cocoa splitting machine that will be used by cocoa farmers to increase and boost productivity and enhance the quality of cocoa products to the highest possible level, devoid of any hazards, dangers, perils or risks.



Figure: Final View Of The Machine

REFERENCES

- **Design, Fabrication and Testing of Cocoa Depodding Machine** Murtala O. Iyanda¹, Elijah A. Alhassan^{2*} and Timothy A. Adekanye Department of Agricultural and Biosystems Engineering University of Ilorin Ilorin, Nigeria
- **Design of a Cocoa Pod Splitting Machine** S.K. Adzimah and 2E.K. Asiam Department of Mechanical Engineering, Faculty of Engineering, Department of Mineral Engineering, Faculty of Mineral Resources Technology, University of Mines and Technology, Ghana
- Khurmi, P.S. and J.K. Gupta, 2005. A Textbook of Machine Design. First Multicolour Edn., Eurasia Publishing House Ltd., 7361, Ram Nagar, New Delhi-110055, pp: 16-50. ISBN: 81-219-25 31-1.
- DESIGN AND FABRICATION OF COCOA POD SPLITTING AND BEAN EXTRACTION MACHINE Arivu. Y1, Manikandan S2, Sivakarathi T3, Gowtham M M4
- **Ntiamoah, A., & Afrane, G. (2008)**. Environmental impacts of cocoa production and processing in Ghana: life cycle assessment approach. *Journal of Cleaner Production*, 16(16), 1735–1740 .<https://doi.org/10.1016/j.jclepro.2007.11.004>
- S.K. Adzimah and E.K. Asiam (2010). “Design of a Cocoa Pod Splitting Machine” International Journal For Scientific Research And Development , Vol. 3, Issue. 06, May 15.