

Design and Fabrication of Groundnut Sheller Machine

Ashish S. Raghtate

P.G. Student

Department of Mechanical Engineering

*KDK College of Engineering, Nagpur, R.T.M. Nagpur
University, Maharashtra, India*

Dr. C. C. Handa

Professor & Head of the Department

Department of Mechanical Engineering

*KDK College of Engineering, Nagpur, R.T.M. Nagpur
University, Maharashtra, India*

Abstract

In India, most of land use for agricultural purpose which produces semi-finished product or goods. Groundnut also one of the agricultural semi-finished goods. Groundnut is grown on small scale farmers in developing countries like India. The average kernel price is approximately twice the price of pod. . Lack of groundnut processing machines, especially groundnut Sheller, is a major problem of groundnut production, especially in our country India. In the beginning the peanuts were separated from its shells by the workers. They simply decoct the groundnut by their hands and separate the peanuts from its shell. The output got from this method, was very low and it does not fulfill the market demand because it was very time consuming process. A research-work for design, fabricate, and performance evaluation of a groundnut Sheller consisting of feed hopper with a flow rate control device, shelling unit, separating unit and power system. The performance of the machine was evaluated in terms of throughput capacity, shelling efficiency, material efficiency and mechanical damage. Regression models that could be used to express the relationship existing between the Sheller performance indices, pod moisture content and feed rate were established. This paper describes about the design and fabrication of various components of groundnut Sheller machine. Hence in this design of various parts are necessary, and design of various parts due to which the design quality of those parts will be improved. Overall, this project involves processes like design, fabrication and assembling of different components etc. By keeping the point in our mind, we think that we should make such a machine, whose production capacity is more & machine gets operated on 1 H.P. electric motor instead of manual work. The new and small former or business man can start their business by investing less capital. So working on the above points, we design and fabricate a new medium production capacity machine and today we proudly present this machine called groundnut Sheller machine.

Keywords: Groundnut, Sheller Machine, Efficiency, Design, Calculations, Fabrication, Assembling, Evaluation.

I. INTRODUCTION

The purpose of this paper is to understand the knowledge of design and fabrication mechanism of groundnut Sheller machine. The design is an environment friendly and uses simple mechanism properties such as shelling system, blower mechanism and automation separating system etc. In this, some crushing force is needed to crush the groundnut. The design is so done that the knowledge of designing, mechanism and forces are increased. This project consists of designing and fabrication of an automatic groundnut Sheller machine considering various important parameters. In this project, designing & development of a machine to crush or shell groundnut so the farmers can gain high profit by selling groundnut direct in market. As well as the study of manufacturing was very important in order to carry out this project to ensure that what are needs to do. This project involves the process of designing and fabrication of different parts of this shelling machine considering forces and ergonomic factor for people to use. This project is mainly about generating a new concept of groundnut shell (crush) that would make easier to bring anywhere and easier to crush groundnut. After the design has completed, it was transformed to its real product where the design is used for guideline.

II. PROBLEM IDENTIFICATION

In the beginning the peanuts were separated from its shells by the workers. They simply decoct the groundnut by their hands and separate the peanuts from its shell. The output got from this method, was very low and it does not fulfill the market demand because it was very time consuming process. It was also a boring work for the worker. Traditional method of separating nuts from groundnuts by Putting the peanuts in a cloth bag and rolling over it with a rolling pin. This technique did a good job of cracking the shells (deleting the painful fingers problem), but we still had to pick the peanuts out since they didn't come all the way loose. This is not a reliable method for shell a ground nut due to this crack the ground nut and nuts mixed with shell. Introduction gives knowledge that the traditional method is not a sufficient method for separating the groundnut. Due to this manual process, identify some major problem & to over-come this problem some idea or concepts generates. According to generated ideas deciding objective of project. Formers and small businessman are facing following main problems:-

- (1) Currently base process is manually operated (pedal operated)
- (2) Nuts & husk (outer covering of groundnut) is mixed after crushing (shelling operation).
- (3) Low productivity & time consuming.

III. PROBLEM FORMULATION

The aim is to design & develop a low cost ground nut shelling machine which will help farmer to sell finished (shelled groundnut) instead of unshelled groundnut. Considering the above problems we are going to design and fabricate such a machine that will eliminate most of the problems from previous available manually shelling machine, so human effort is reduced and getting more productivity, earn more profit to former. The machine shown in figure below is the modeling of groundnut Sheller machine.

A. Concept

Introducing low cost automation was to overcome problems with the current manual traditional method. The concept of the work is,

- (1) Observe the manual methods to identify the important process variables.
- (2) Quantify the important method.
- (3) Develop a prototype automation system which could control over all of the process.
- (4) Investigate all areas of automated forming.
- (5) Produce a specification for a low cost automated system.
- (6) Refined design of the machine & fabricate the machine, as this plays a major role in rural area.

The above considering point we design the semi-automated machine which replace manual process.

B. Objective

The main aim of this project is to overcome the traditional method.

- (1) To reduce wastage due to crack or crushed groundnut.
- (2) To increase the efficiency.
- (3) To reduce the hard work and To reduced time to shell the groundnut.
- (4) To develop a low cost machine which can be used by farmer to convert their semi-finished (shell groundnut) into finished product (groundnut).
- (5) It satisfies the need of village people to earn more money.

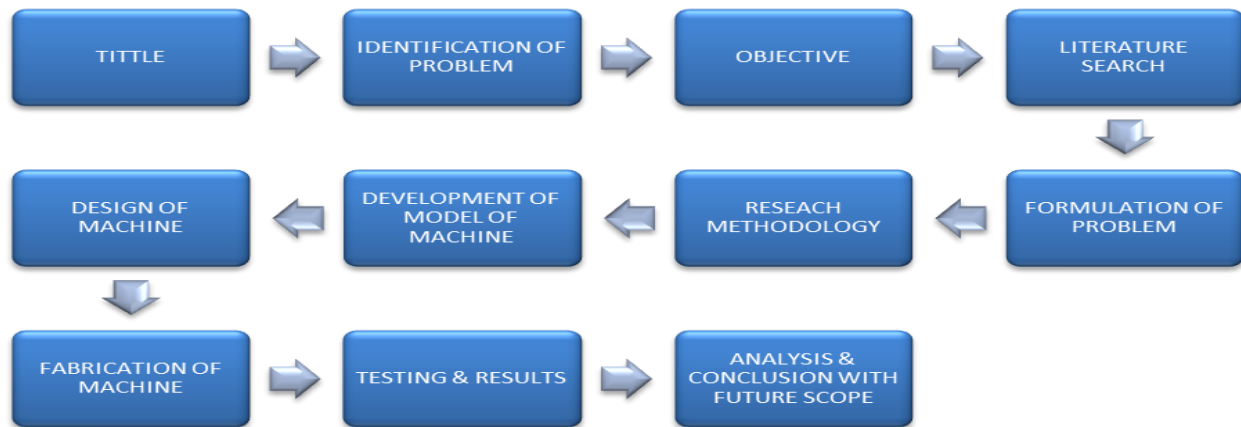
IV. WORKING PRINCIPLE

Groundnut SHELLER is operated on the shearing action blowering action and separating action. Firstly the inputs i.e. the groundnut are fed to the machine through the hopper. Then groundnuts come in contact with the two members, one is semicircular net and another is roll shaft. Semicircular net is a stationary member while the roll shaft is rotating member. When the groundnut comes in contact with these two members then the shearing action takes place here. Due to shearing action (crushing) the groundnuts gets shelled and divided into two parts. i.e. in the peanut and outer shell of the groundnuts. There clearance is provided between the net and roll shaft. The clearance provided is depends upon the size of the groundnuts which is to be decocted. After shelleing the groundnut the peanut and shells of the groundnut gets dropped from the semicircular net, in downward direction then a centrifugal force is applied by a fan on the peanut and shell of the groundnut. Due to more weight, the peanuts gets moved downward and collected in the separator. But due to lighter weight the shell of the groundnuts are thrown outside the machine and which are collected from the backside of the machine. From the shelling chamber the unshelled groundnuts also gets dropped in the tray (7% to 10%). This groundnut gets dropped from the clearance made among the grill. The three kinds of the nets can be used with different size of capsule slots, size vise small, medium and large for various size of groundnuts. In this way the "GROUNDNUT SHELLER" works.

V. RESEARCH METHODOLOGY

Research methodology deals with design &fabricated all of component which are to be used in the machine with required modification. Firstly synthesis the all the problem which are consult with project. After that design complete atomize machine, then regarding development done on shelling machine. Parameters will be selected according to objectives. 2D & 3D diagrams of components and assembled machine and line diagrams with labeling. The various instruments used for fabrication of machine. As seen on last project, it is based on manually operated (paddle operated). Existing project will be modified by making motorized (semi-atomize). Another problem is that nuts and husk is mixed coming after shelling operation, this problem will be remove by using blower or other mechanism to separate nuts and husk (outer covering of a ground nut). By making motorization (semi-atomizing) productivity improve with minimizing time consuming and damages of nuts, capacity also improve. The approach will be synthesis, design, development & testing of the machine. By keeping the point in our mind, we think that we should make such a machine, whose production capacity is more & machine gets operated on 1 H.P. electric motor instead of manual work.

The new and small former or business man can start their business by investing less capital. As last system is manually operated it is now modified by automatic one.



Plan of Action

A. Designing of Machine

1) Design Of Belt On Main Shaft Pulley

According to Kick's relation Power required to shell groundnut

- (1) $H = KKFC \ln(L1/L2) = 654.1$ watts
- (2) Selected motor 1hp, 1440 rpm
- (3) Speed of main shaft $N2 = 240$ mm
- (4) Speed of blower shaft $N3 = 720$ rpm
- (5) Velocity ratio is 6 for shelling and velocity ratio for blower 1/3 of shelling speed
- (6) Motor pulley diameter, $D1 = 75$ mm
- (7) Shaft pulley diameter, $D2 = 450$ mm
- (8) Design power, $Pd = 0.8206$ kw
- (9) $Vp = 339.29$ m/min
- (10) For v-belt drive $Vp = 300$ to 1500 m/min Vp in range so selected velocity ratio is correct.
- (11) Power/belt = 2.378 KW
- (12) No. of belts, $n = 1$
- (13) Length of belt, $L = 2$ m
- (14) Bending load, $Fb = 39.11$ N

2) Design Of Bigger Pulley On Main Shaft Pulley

- (1) Width of pulley, $w = 21$ mm
- (2) Pitch diameter, $Dp = 200$ mm
- (3) Arm-construction(4 arms)
- (4) Rim thickness, $t = 11$ mm
- (5) No. of sets = 1
- (6) No. of stand = 1 (singal stand pulley)

3) Design Of Main Shaft

- (1) Design torque, $Td = 51.944$ N-m
- (2) Belt tensions, $T1 = 446.403$ N, $T2 = 215.5$ N
- (3) FORCE CALCULATION
- (4) Wt. of bigger pulley, $WpA = 60.82$ N
- (5) Wt. of smaller pulley, $WpD = 30.41$ N
- (6) wt. of main shaft with blades, $Wsh = 82.4$ N
- (7) $Rvc = 63.141$ N-m
- (8) $Rvb = 110.489$
- (9) Resultant moment, $Mc = 156.2$ N-m
- (10) Selecting shaft material SAE 1030
- (11) $Tmax = 44.4$ Mpa

- (12) Diameter of shaft , $D_{sh} = 30\text{mm}$
- (13) Pulley Hub diameter, $D_h = 70\text{ mm}$
- (14) Pulley Hub length $L_h = 45\text{mm}$

4) Design Of Pulley On Blower Shaft Pulley

- (1) Dia. Of blower pulley, $D_4 = 75\text{ mm}$
- (2) Dia. Of pulley, $D_3 = 225\text{ mm}$
- (3) Length of belt, $L = 2.1\text{ m}$
- (4) Forces on belt, $T_1 = 843.69\text{ N}$, $T_2 = 382.28\text{ N}$
- (5) Width of belt, $w = 13\text{ mm}$
- (6) Thickness of belt , $t = 8\text{ mm}$
- (7) Arm construction type
- (8) No. of arms = 4
- (9) No. of set = 1
- (10) No. of stand = 1

B. Modeling & Fabrication

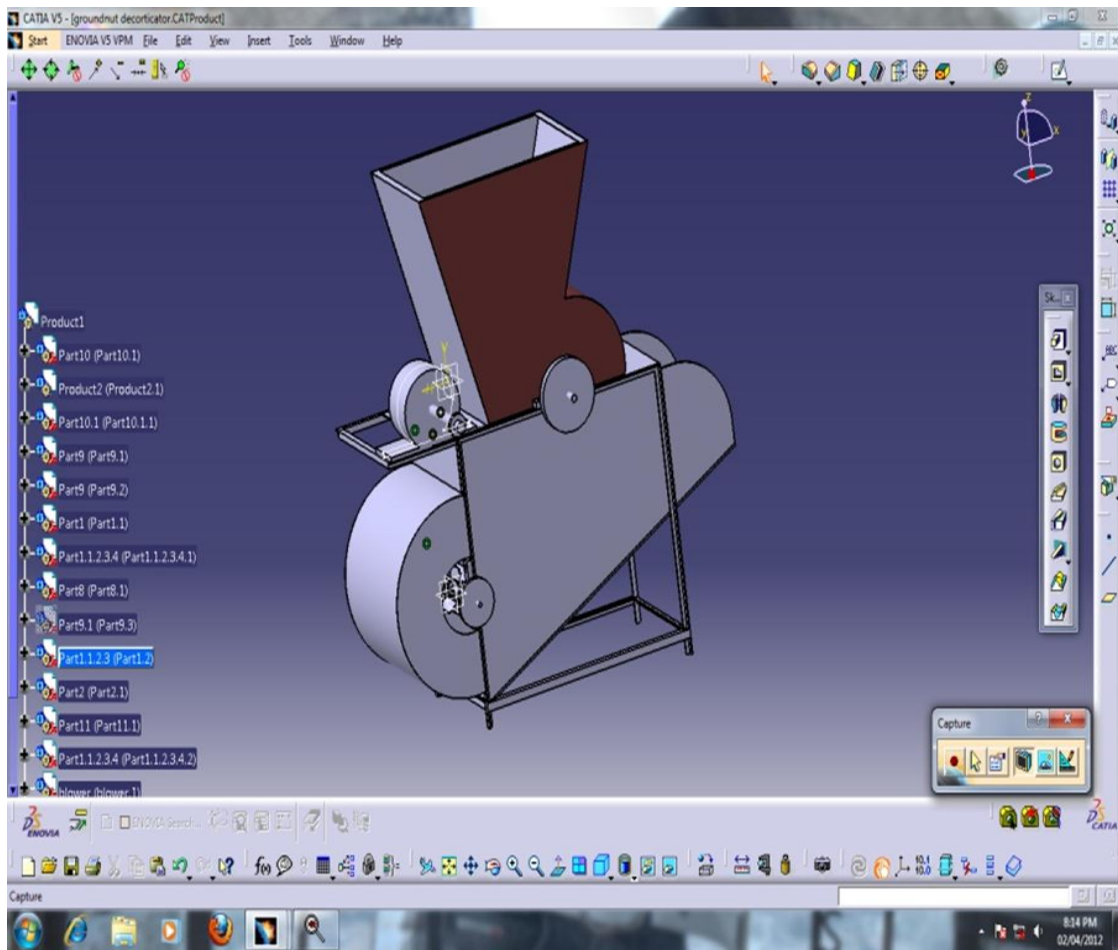
After that design complete semi-automize machine, then regarding development done on shelling machine. Parameters will be selected according to objectives. 3D diagrams & photos of each components and assembled machine and line diagrams with labeling. Main objectives of this project were to develop the first prototype of an easy to use, low priced and efficient ground nut decorticator and test its performance. Taking leads from previous researchers following design constraints were established. Design should be easy to maintain and should not require highly skilled labor, which is difficult to be found in rural areas. Design should be based on easily available material in rural areas. Manufacturing process should be simple and based on locally available machines in rural areas. The various instruments used for fabrication of machine. Following are the main components of machine:-

- (1) Hopper
- (2) Semicircular Net
- (3) Roll Shaft
- (4) Fan Shaft
- (5) Pedestals Bearing
- (6) Pulleys
- (7) Foundation Frame
- (8) Fan Cover

C. Assembly

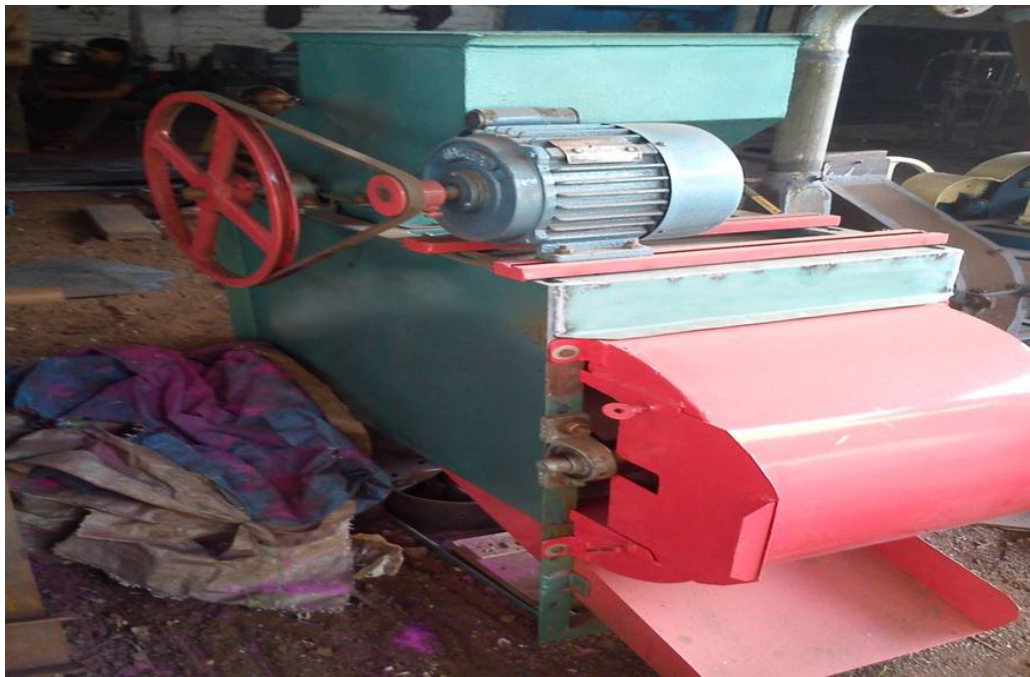
The arrangement of various component of “Groundnut SHELLER” is being done are as follows:

- (1) The foundation frame is being selected which carry the entire load of the machine.
- (2) The roller shaft is mounted on the top face of the foundation frame with the help of pedestals bearing which is fasten using nut and bolt.
- (3) The fan shaft is mounted at the back face of the foundation frame with the help of pedestals bearing which is fasten using nut and bolt.
- (4) The semicircular net mounted on the support provided at inner side of the foundation frame.
- (5) The hopper is mounted on foundation frame covering rolling shaft, and permanently fastened at one side using hinged, and other side is temporary fasten for time to time change of semicircular net.
- (6) Fan cover fastened using nut and bolt to back side of foundation frame, which cover fan shaft.
- (7) End of foundation frame (top face) carry the electric motor, which provide necessary power.
- (8) 18 inch, 9 inch, and 3 inch pulley is mounted on roller, fan and motor shaft respectively, over which belt is mounted for transmission of power.
- (9) The above arrangement ensure that all element of the project are balanced and also center of gravity of the assembly is on axis as that of the center of gravity human body that is on spiral cord.



Final Model of Groundnut Sheller





Final Assembly of Groundnut Decorticator

VI. TESTING AND RESULTS

Sample is selected according to the research work done in previous chapter . The sample is brought from market (mandi). It is sun dried for one day to remove moisture contend. Sample contains unshelled groundnut and some soil adhered to shell. As we discussed about the working principle and experimental set up of testing Machine in the previous chapter, accordingly research we decide one sample & testing can done five times. After taking reading, calculating total sample reading and this total reading give mean reading. This mean reading help us to calculating result of Sheller machine. As the experimental set up of machine shown in the previous chapter regarding this, the sample reading are tabulated in the following table. In testing table following parameters are mention like, wt. of sample, wt. of shelled nuts and time required to shelled groundnut. The testing of the system was done and the following results were observed:-

Testing Table

Sr. No.	Total Wt. Of Groundnut In Kg. (Q_t)	Wt. Of Shelled Groundnut In Kg. (Q_s)	Wt. Of Undamaged Groundnut Seed In Kg. (Q_u)	Wt. Of Damage Groundnut Seed In Kg. (Q_d)	Time To Shelling Operation In Sec. (T_m)
1	1	0.83	0.645	0.185	23
2	1	0.81	0.655	0.155	21
3	1	0.8	0.64	0.16	20
4	1	0.82	0.65	0.17	25
5	1	0.8	0.655	0.145	23
Total	5	6.06	3.245	0.815	112
Mean	1	0.812	0.649	0.163	22.4

From testing we conclude that we can save the time and money, by using groundnut decorticator. In this machine if we put the 1kg of groundnut in the groundnut Decorticator” then we get the output of 0.8 kg of decayed seeds. In same manner if we put the 5kg of groundnut in the groundnut Decorticator” then we get the output of 6.0 kg of decayed seeds. So if we go on continuous work on machine we got greater output in very short time. If we put input in large amount then we got the more output from machine with a minimum wastage. That is if we put the 50kg of groundnut in the “Groundnut Decorticator” then we get the output of 40 kg of decayed seeds.

A. Results:-

$$(1) \text{ Shelling efficiency (\%)} = [Q_s / Q_t] \times 100 \\ = 81.2 \%$$

- (2) Material efficiency (%) = $[Q_u / (Q_u + Q_d)] \times 100$
= 79.93 %
- (3) Mechanical damage (%) = $[Q_d / (Q_u + Q_d)] \times 100$
= 20.07 %
- (4) Throughput capacity (kg/h) = $[Q_s / T_m]$
= 130.5 kg/hrs.

Above results can show that, our project can shell 81.2% groundnut with 20.07% damage. Groundnut Sheller machine capacity 130.5 kg per 1 hrs.

VII. ANALYSIS

Analysis is the process of breaking a complex topic into smaller parts to gain better understanding of it. In this chapter, we analyzed the efficiency of motorized Sheller machine with Sheller machine based on other principles which are discuss in chapter 4 review of literature. In analysis we compare the parameter which relate to efficiency of machine and give the idea which type of machine is suitable for high productivity with low cost production of machine. In this chapter we also, discuss pay-back period of machine, which calculate how much time required to earn machine price money. Following points are explain the comparison of sheller machine with other based principle machine:-

- (1) Average efficiency for JH grade and WB grade was found to be 75.75% and 72.97%, respectively. Overall, average efficiency was found to be 74.36%.^[2]
- (2) Maximum shelling and winnowing efficiencies of 80% and 79.5% respectively.^[3]
- (3) The forward facing impeller with eight slots gave the best shelling efficiency of 96, 77.8 and 62% Moisture content of 5.3% (d.b.) gave shelling and winnowing efficiencies of 96 and 87.3%, respectively, for the forward facing impeller with eight slots, 86.6 and 85.3%, respectively, for the radial impeller with eight slots, and 85 and 83.7%, respectively, for the backward facing impeller with eight slots.^[4]
- (4) The shelling efficiency was found to be 90.2, 91.9 and 85.7 % on the average for ICGV-SM-93523, Samnut 10-Rmp 12 and Samnut 10-Rmp 9 varieties of groundnuts, respectively. The shelling efficiency of the machine was found to be highest (91.9 %) in the shelling of Samnut 10-Rmp 12 variety of groundnuts. Also, the average shelling efficiency of 89.0% for the three varieties of groundnuts is quite commendable.^[5]
- (5) The shelling efficiency ranged from 95.44 to 95.27 and 98.92-98.86% at feed rate ranges of 80-120 and 140-180kg/h at box speed of 1.4m/s and moisture content about 17.12%d.b. The cleaning efficiency ranged from 99.01 to 98.79 and 99.17 to 98.93% at feed rate ranged from 80 to 120 and 140 to 180kg/h at box speed of 1.4m/s, air velocity of 8.37m/s and moisture content about 17.12%d.b. for the Sheller.^[6]
- (6) The shelling efficiency when operated electrically with 10 kg of groundnut sample performed at 78% and 85% for shelling and cleaning efficiency respectively, with a mechanical damage of 1.1%. the throughput capacity of machine is 345.4kg/hrs. the manually operated Sheller has 5kg of groundnut sample and performed at 65% shelling efficiency with mechanical damage of 2.8% %. the throughput capacity of machine is 118.9kg/hrs.^[7]
- (7) The shelling efficiency when operated electrically of roasted groundnut sample performed at 66% and the manually operated Sheller has roasted groundnut sample and performed at 55% shelling efficiency.^[8]

VIII. CONCLUSION

Proper evaluation of the design will be performed and created something even better instead of simply manually operated operations. Finally we conclude that atomize machine is better option to use farmer instead of manually operated. The demands atomize shelling machine of farmer & other customers will be also considered while designing machine. Purpose of fabrication of the Sheller was to determine the suitability of machine for farmer's use. Five experiments were performed with peanuts. Since this machine is made for small businessman or for farmers, therefore the work carried out by this machine is less. The capital required for purchasing the bigger size groundnut decorticator is very high or the cost required for decorticating the groundnut on the job work is also more. In comparison these "Groundnut Sheller" is very cheap. We have selected the "GROUNDNUT SHELLER MACHINE" as our project work. The "GROUNDNUT SHELLER MACHINE" is the ideal equipment for decocting process. In the process of completion of the project work our ideas and thought are development towards the mechanisms and technologies of the equipment. We also visualized that this "GROUNDNUT SHELLER MACHINE" is the most critical equipment for the future growth and development of cottage sector projects.

Similarly we can say that for the purpose of decocting the groundnut this is economical and ideal in case of cottage sector projects. The "GROUNDNUT SHELLER MACHINE" can be used in cottage industry or even a former can also take benefit from this machine. The decocting process of groundnut by this machine is more economical and faster than manual process or any other processes. Therefore on the completion of this project, we conclude that the "GROUNDNUT SHELLER MACHINE" will save the tremendous time, energy manpower and save financial input of the project, reducing the cost and time considerably which is the backbone of the present world economy.

IX. FUTURE SCOPE

Future scope of work is what is required to be delivered. It is importuned that future scope statement is clear unambiguous and easily to understand. It should also include details leaving the reader in no doubt what is being delivered as part of project. The groundnut Sheller, with sufficient market penetration, would offer a substantial in shelling efficiency. Most shelling is done by hand in groundnut producing region of the developing world. This type of task is usually done by woman. The low cost groundnut Sheller is a case of intermediate technology. Ultimately, it could significantly reduce groundnut processing time for rural women and farmer, opening up time for other task.

Following are the future scope of machine which will give more output to owner.

- (1) Shelled nuts are in different sizes. Per kg price of nuts varies according to size of nuts. For fetching premium quality nuts grading system can be attach at nuts outlet of Sheller machine.
- (2) Electric sensor based automated flow control can be added at bottom end of hopper to continuous and proportionate constant flow of ground nut.
- (3) While shelling of ground nut, soil stucked to shells enters in to the nuts. To remove soil particles soil removal system (grading system) can be attached.
- (4) If we provide the arrangement at the outlet of shells, we can better control the dust.
- (5) If we provide the arrangement at the outlet of shells, we can better control the dust.
- (6) In "GROUNDNUT SHELLER" if we connect the gear train or chain drive so we can operate it with the help of bull instead of electric motor Or it can be run on the 0.5 H.P. with same output.

REFERENCES

- [1] J. N. MADUAKO and M. HAMMAN "Determination of Some Physical Properties of Three Groundnut Varieties".
- [2] A.Mishra, R. Soni and J. Mangla, "development of a low cost peanut decorticator for use in Developing countries" Synergy and Technical Development (Synergy2009) Gödöll, Hungary, 30. August – 02. September 2009.
- [3] A.A. Atiku, N.A. Aviara and M.A. Haque, "performance evaluation of a bambara ground nut Sheller," Agricultural Engineering International: the CIGR Journal of Scientific Research and Development. Manuscript PM 04 002.Vol. VI. July, 2004
- [4] F.A. Oluwole*, A.T. Abdulrahim, and M.B. Oumarou," Development and performance evaluation of impact bambara groundnut Sheller"
- [5] J. N. Maduako, M. Saidu, P. Matthias, I. Vanke, "Testing of an engine-powered groundnut shelling machine," Journal of Agricultural Engineering and Technology (JAET). Volume 14, 2006
- [6] M.A.Helmy, A.Mitroi, S.E. Abdallah,Mohamed, A. Basiouny "Modification and evaluation of a Reciprocating machine for shelling peanut," Misr J. Ag. Eng., 24(2): 283-298
- [7] Abubakar Mohammed &Abudulkadir B. Hassan, "Design & Evaluation of motorized & manually operated groundnut shelling machine," international journal of Emerging trends in Engineering development Issue 2, vol.4 (may 2012)
- [8] OladejiAkanniOgunwole, "Design, Fabrication & Testing of manually & electrically operated roasted groundnut decorticating machine," Food Science and Quality Management www.iiste.org ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online) Vol.14, 2013
- [9] Shelling Equipment for sample of Peanut, by James dickens, Agricultural Engineer U.S. Department of Agricultural
- [10] Design for a pedal driven power unit by David Weightman, Lanchester polytechnic, United Kingdom.
- [11] ShiwalkarB.D., "Design data for machine elements", 2010 Denett& Company.
- [12] Rattan S.S, "Theory of machine", edition 2012, S.Chand Publication.
- [13] Bhandari V.B., "Design of machine elements".3rd edition,2010 the Tata McGraw Hill Education Private Limited. J. R. Immer, Material handling, Mcgraw Hill book company pvt.Ltd.,Dec 1953
- [14] R. S. Khurmi" and "J. K. Gupta", Theory of machine by, S Chand and co ltd, 14 edition, Aug. 1, 2005
- [15] HajraChaudhari S.K. and A.K., Workshop technology, Arnold Publication,1956