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Design of a simple mobile peanut butter/Cooking oil Manufacturing Plant

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Abstract: The objective of this work is to design and develop an improved peanut butter manufacturing plant terms of better time management, affordable cost, portability and mechanical efficiency. The improvement of this simple manufacturing plant basically comprises five important stages; the conveyer stage, shelling stage, roasting stage, peanut butter/oil processing stage, packaging stage, the other parts are hopper, shelling chamber, separating chamber, distributing hopper, pan, frying stick, heating element, automated robotic mechanism, eight wheels, Motors 10HP. The arrangement of these parts is that wheels are connected to the flame and all stages are mounted on the flame the material for the shelling shaft is taken to be mild steel. The materials of the machine are sourced locally so as to ensure that it is mobile, easy to maintain, cheap, affordable and easily operated by the peasant farmers. The machine employs an auger screw as a means of breaking the groundnut pod. The mobile manufacturing plant shelling efficiency and material damage are 84% and 14% respectively for groundnut seeds in this work its pealing, shelling efficiency without breaking the nuts. The machine can only be operated using power. The efficiency of the Mobile Manufacturing Plant is 91-95% and the production cost is k35000 Zambian currency (approximately $3500).

Keywords: Groundnut, Peanut butter, cooking oil, shelling, roasting, Efficiency, Design Calculations, Assembling, CAD and Evaluation.

1.0 INTRODUCTION

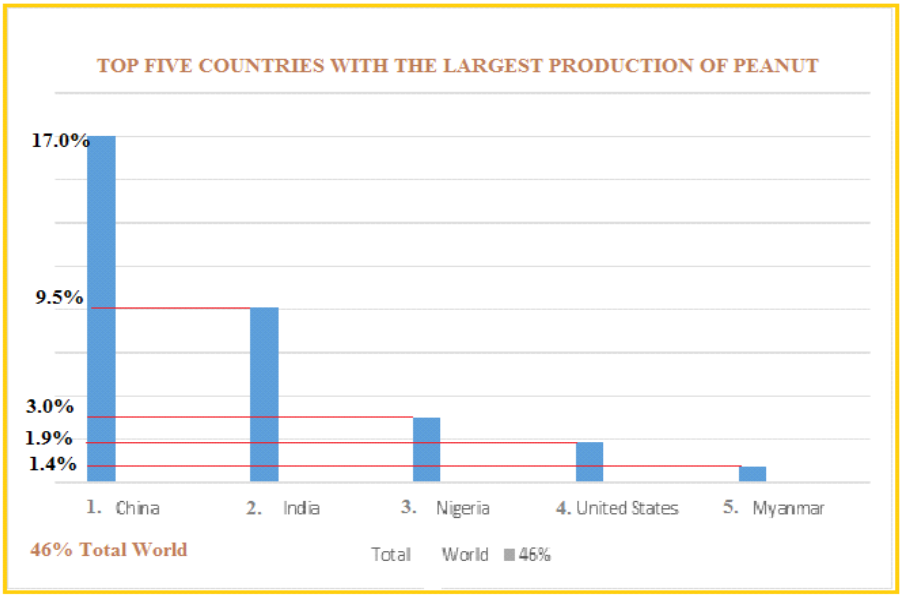
The purpose of this papers is to design and make a simple mobile peanut butter/cooking oil manufacturing plant. The design and technology of this manufacturing plant uses simple mechanism properties such as conveyer mechanism, shelling system, browering mechanism, roasting, pealing system, browering system, peanut butter processing system, packaging process which is manual, mechanical and automatic. In this, some crushing force is needed to crush the groundnut. The design is so done that the knowledge of designing, mechanism, electronic, forces and sensors are increased.

In this project, designing and development of a manufacturing plant to shell groundnut, roasting, peanut butter processing and packaging so the farmers can gain high profit by selling peanut Butter, cooking oil direct in market to prevent labour of transportation. This project involves the combination of a conveyer technology, groundnuts shelling technology, electronics roasting technology, pealing technology, seed grinding technology and the packaging technology. The process of designing, fabrication and assembly of different parts of this mobile peanut butter/cooking oil manufacturing plant considering forces and economic factors for people to use. This project is mainly about innovation and generating a new concept while innovating a simple mobile peanut/cooking oil manufacturing plant that would be mobile.

Here is evidence that peanut butter is important worldwide people use it in different ways and is a good source of proteins and energy giving food. The briefly history about the groundnuts ancient South American Inca Indians were the first to grind peanuts to make peanut butter. In the United States, Dr. John Harvey Kellogg (of cereal fame) invented a version of peanut butter in 1895. Then it is believed that a St. Louis physician may have developed a version of peanut butter as a protein substitute for his older patients who had poor teeth and couldn't chew meat. Peanut butter was first introduced at the St. Louis World's Fair in 1904.

Peanuts and peanut butter became an integral part of the Armed Forces rations in World Wars I and II. It is believed that the U.S. army popularized the peanut butter and jelly sandwich for sustenance during manoeuvres in World War II.

CHART 1



2.0 MATERIALS AND METHODS

2.1 Materials and Components

The selection of these materials was based on durability, cost and availability, strength and rigidity, weight and friction, the whole frame of the Peanut Butter Manufacturing Plant is made of high-quality steel.

Following are the major components of a Mobile Peanut Butter Manufacturing Plant in the five stages.-

Table 1.Conveyor process

.a	Head Pulley	.d	idlers
.b	Loading hoppers	.e	Transition Idlers
.c	Impact idlers	.f	loading Hopper
.d	Caring belt training idlers	.g	Belts

Table 2. Nuts shelling process

• Vibrator	• Peel Hopper
• Pulleys	• Peeling roller

• motor	• Fun
• Feeding Hopper	• Discharging Chutes
• Belt Cover	

Table 3. Roasting process

• Heat Element	• Brower
• Flying stick	• Fun
• Pan	• 24V motor
• Pealing Device	.g cooling System
• Load	

Table 4. Peanut butter process

• Feeding Hopper	• Chuck
• Shelling Pad	• Pulleys
• Oscillating sector • Twin Shafts, in Gear form	g. Two Different types of valves 0.1mm Diameter and 0.5mm Diameter
• Smooth Round shaft	

Table 5. Packaging process

.a lid-holder disc .b Bottle discharge unit	.d conveyor .e. simple robotic/automatic
.c Sensors	

3.0 Designing of a Manufacturing Plant

Assembly of all Five stage with components is done using fabrication and bolts and nuts different sizes of in the fabrication of this Mobile Peanut Butter manufacturing plant. These stages are: the conveyer stage, shelling stage, Roasting stage, peanut processing stage and the packaging stage.

3.1 The conveyor

Belt conveyor system is the transportation of material from one location to another location. The type of a conveyer used in this project is the Elbow up Slider Bed conveyer because

design is easy and inexpensive to maintain and an affordable conveyor for light to medium loads the conveyor belt plays a greater role by carrying the groundnuts from the ground level to the feeder 3000mm high which a human being cannot afford and labour expense. It is mounted on the base flame using bolt and nuts and it has a high load carrying capacity up to 50Kg, set at an angle of 60 degrees, path is 1500mm, simple design, easy maintenance and high reliability.

3.2 Shelling stage

Shelling stage consists of rasp bar, stake, intaglio, fan, gravity separator and second bucket, etc. After starting, the shells of peanuts are shelled by the rolling force between the rotating rasp bar and the fixed intaglio, and then shells and kernels fall through the grid mesh down to the air duct, and the fan blows shells out The shelled nuts are distributed to the roasting process through the distributing hopper;

Frame	It holds the hopper, shelling, and separating unit as well as the prime mover (electric motor). Being the main support for the machine, it must be able to withstand stresses and loads and have good welding properties. Hence, mild steel in form of angle bar was used.
Hopper	It contains the unshelled groundnut before and during the shelling operation. It must be able to withstand the vibration loads and stresses, have good strength and good corrosion resistance. Hence, the material is mild steel sheet of 2mm thickness.
Shelling Chamber	The shelling chamber is made of stainless steel, It houses the auger and the shelling drum. The shelling operation is done inside it. Therefore, it must be able to withstand load and stresses, good weld ability and corrosion resistance. The diameter of the shelling drum is 300mm and pitch of the anger screw is 130mm.The active length of the drum is 700mm. So, mild steel thickness of 2mm.
Seed Discharge Outlet	The shelled groundnut seed is collected through this outlet. The seeds fall under gravity from the shelling chamber into its tray to the roasting process. It must have good strength and high resistance to impact loads. So, mild steel of 2mm thickness to be used.
Chaff Outlet	The broken pod is separated from the groundnut by pressure provided from the fan. Mild steel thickness of 2mm s.
Fan	It is made from aluminium due to its light weight. It has diameter of 50mm with length of 400mm and 2mm thickness.

3.3 Roasting Stage

The roasting stage has the following components; The Pan, Heating Element, Flying stick, flat load, pealing chamber, the Brower and a 24V motor. In this stage the shelled groundnuts seed automatically drops into the pan for roasting, The technics and mechanism used in roasting came from the popping machine, the metal stick is responsible in the flying of which is attached to a 24V motor which apprise circular motion, after the seeds roasts drop into a cooling system in order the pealing process to take place nicely, then the pealed seeds drops into the pealing chamber which is designed with rough soft rubber inside with a horizontal rotating shaft which is connected to the 24Vmotor. After the pealing process the roasted seed is ready to undergo the peanut butter processing stage.

Pan	The pan is made of high carbon steel designed in rectangular form
Heating Element	Is attached at the base of the pan to produce normal heat.
Flying stick	It is made of cast steel.
pealing chamber	The pealing chamber is made of stainless steel, The diameter of the pealing chamber is 250mm, The active length of the drum is 500mm, thickness of 3mm
Fun	Is responsible in the blowing to get rid of residues
cooling system	The cooling system is made of wood material to quickly cool the roasted seeds in order the pealing process to take place effectively.
soft rubber	Soft rubbers plays greater role of pealing without damaging the seeds, rubbers are inserted in a spiral way inside the pealing chamber to maintain the separation. The rubber are attached 5mm space in between but in spiral form they are 4mm Diameter, length of 35mm with a collar of 3mm in between and 2mm from the edge.
24V motor	The motor drives both the flying stick and the pealing shaft at slow speed
Pealing shaft	The shaft is covered with soft rubbers around it, the diameter of a shaft is 140mm including the soft rubbers makes 190mm diameter

3.4 Peanut Processing Stage

Under this stage the machine is designed in adjustable way such that it can grind seeds to liquid form. Therefore, not only peanut butter can be manufactured but also cooking oil can be manufactured, the seeds is feed automatically into the feeding hopper of peanut butter processing stage by gravity and vibration within the flying stage. The technology applied in the distribution of butter or cooking oil came from the Tap (valve) to close and open when necessary. Where it has three provision of connecting taps.

Feeding hopper	Roasted seeds drops into the hopper from the pealing process. It is made from mild steel sheet of 2mm thickness.
Taps	Three taps are connected to the mixing chamber the function is to fill up bottles with peanut butter or cooking oil.
Chamber	The chamber is 3mm thickness made of mild steel.
Shaft	The shaft is connected to grinding disc which crushes roasted and peeled seeds into peanut butter and if is to produce cooking oil seed are not supposed to pass the third stage which is roasting stage and another different grinding disc must be inserted to crushes up to oil.

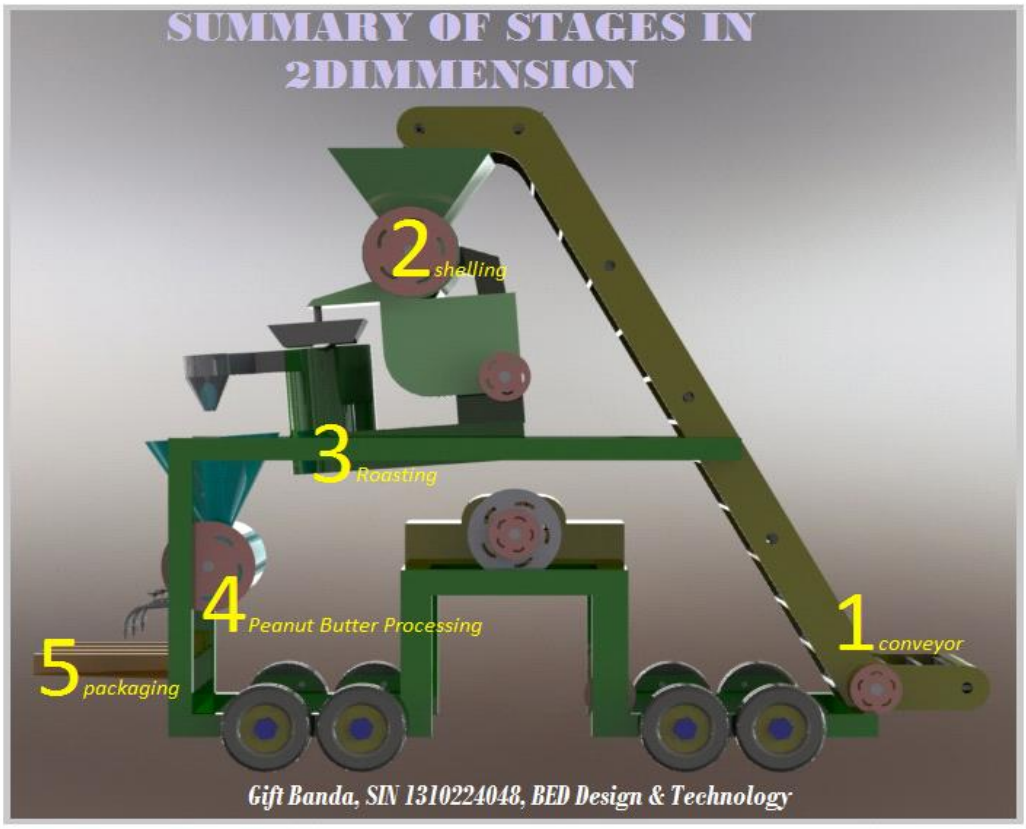
3.5 Packaging Stage

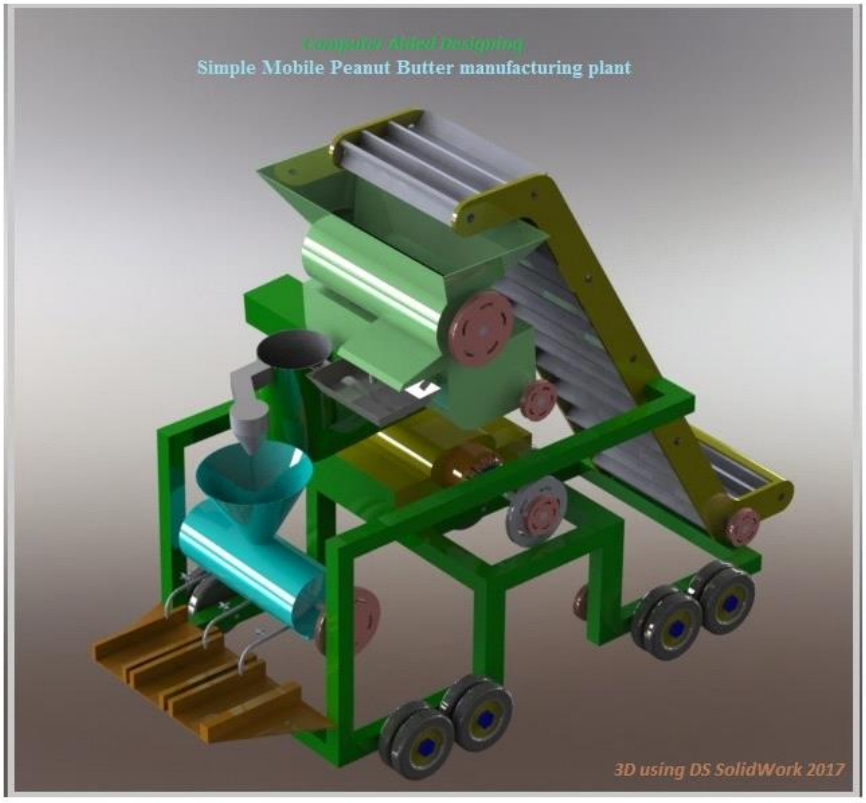
The Packaging stage involves the filling, closing and packing of peanut butter or cooking oil into bottles. Stage bottles are filled with peanut butter and rids are closed automatically by simple Mechanism. Positioning pushers stabilize the bottles onto the exit conveyor. The system allows bottles being positioned into pucks.

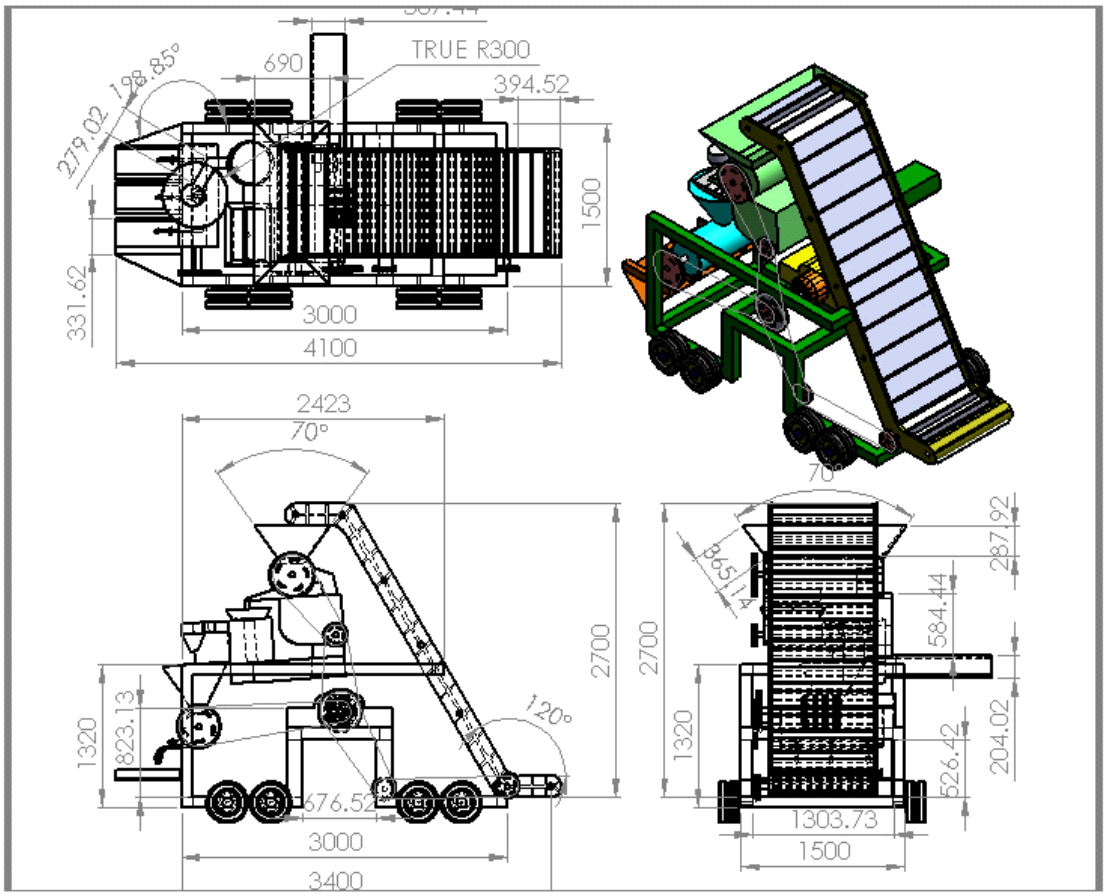
4.0 Assembly

The arrangement of various component of a "simple mobile manufacturing peanut butter Plant" is being done are as follows:

- The foundation frame is being selected which carry the entire load of the machine with eight wheels.
- The Manufacturing plant has only one engine of 10hp which runs the conveyor, shelling process and the peanut butter processing.
- The Conveyor with all its components after assembled is being mounted on the top face of the foundation frame using bolt and nut.
- The groundnuts shelling machine with all its components is assembled and mounted at the face of the conveyor and the base of a foundation frame using bolt and nut.
- The flying mechanism with all its assembled equipment's and components is direct mounted on the foundation frame with less connection to the shelling stage.
- The Peanut butter processing system is mounted on the flame with the connection of bolt and nut.
- The Packaging system with all its components is direct connected to the flame.
  Arrangement of these components ensure that all element of the project are balanced and also centre of gravity of the assembly is on axis.
  Below are the blue print based on detailed Computer Aided Designing of the Manufacturing Plant in both 2Dimension and 3Dimention.


SUMMARY OF STAGES IN
2DIMMENSION
2 shelling
3 Roasting
4 Peanut Butter Processing
5 packaging
1 conveyor
Gift Banda, SIN 1310224048, BED Design & Technology


Computer Aided Designing
Simple Mobile Peanut Butter manufacturing plant
3D using DS SolidWork 2017



5.0 DESIGN ANALYSIS

5.1 Design Of a conveyor

Specification

Belt width = 1.2m
Belt thickness = 0.008m
Angle = 60Degrees
Feeding height = 2500mm (loading)
Total length of belt = 10,000mm
Centre to centre distance = 7.9m
Drive unit = Gear driven roller diameter 190mm
Conveyor speed = 3rpm

5.2 Design Of a Belt On Shelling Stage.

Kick"s states that relation Power required to shell groundnut

- H =KKFC ln(L1/L2) = 654.1 watts
- Selected motor 10hp, 1440 rpm
- Thickness of belt , t = 8 mm
- Velocity ratio is 6 for shelling and velocity ratio for blower 1/3 of shelling speed

- Motor pulley diameter, D1 = 360mm
- Length of belt, L = 3200mm

5.3 Design of Bigger Pulley

- Dia. Of pulley, Diameter= 360 mm
- Rim thickness, t = 40mm

5.4 Design Of a Small Pulley

- Dia. Of pulley, = 190 mm
- Rim thickness, t = 40mm

5.5Design of a Roasting Machine

The roaster has two plates elements connected to the base of the pan, the gap left between the pan and the elements is 2millimiters to prevent it from overheating the pan. At this stage the shelled groundnuts seed automatically drops into the pan for roasting, the stick is responsible in the flying of which is attached to a 24V motor which apprise circular motion, after the seeds roasts drop into a cooling system in order the pealing to take place nicely, then the seeds drops into the pealing chamber which is designed spiral inside to allow the separation, with brushes made of soft rubber. After the pealing process the roasted seed is ready to undergo the peanut butter processing stage. The motor is mechanically connected to drive rotate both the flying stick and pealing shaft

5.6 Design of peanut butter machine

a. Hopper Design

The hopper design is based on the volume of frustum of a pyramid. The volume of the pyramid is obtained by subtracting the volume of a smaller pyramid from that of a larger one as given by Khurmi and Gupta (2004)

Where R = outer radius, H = external height, r =inner radius and h = internal height. There values are 150 mm, 400 mm, 70 mm and 120 mm respectively,

5.5 design of an automatic Packaging machine

The flame of Packaging process is made of made of stainless steel SS304 which is connected to the base of the flame. It is designed in a way that it fills up three bottle of peanut butter or cooking oil at a same time.

- Parts which are in contact with product made of stainless steel SS316
- Moving unit for bottle & lid-holder disc there are pins around the cavity on rotary turret to hold the lids. The bottles magazine has a step to hold the cups during discharge)
- Lid sealing device it is done Mechanical.
- Bottle discharge unit with conveyor length = 1500mm
- A small conveyor moves the bottles and stops at each station for undertaking individual functions in simple robotic/automatic mode

- Three empty bottles are first discharged into the simple conveyor by manual operation.
- The bottles are then discharged from the conveyor 1 metre for collection & final packing.

6.0 RESULTS AND DISCUSSIONS

Calculations
Calculations of a groundnut sample.
Total weight of groundnut in kg (Qt),
Weight of decorticate groundnut in kg (Qs),
Weight of undamaged groundnut in kg (Qu),
Weight of damaged groundnut in kg (Qd) and
Time to decorticating operation in sec(Tm).
1) Decorticating efficiency = (Qs/Qt) x100
= (1.184/2) x100
= 59.2%
2) Shelling efficiency (%) =
[Qs / Qt] x 100 = 81.2 %

3) Material efficiency = (Qu/Qu+Qd)
X100
= (1.074/1.074+0.110)x100
=90.70 %
4) Mechanical damage = (Qd/Qu+Qd) x100
= (0.110/1.074+0.110)x100
= 9.29 %
Calculations of seed
50,000g of seed produces 23,000grams of peanut butter
50ks=23litres
1000mls bottle fills up with peanut butter in 66seconds
50,000g of seed produces 14,000grams of cooking
=100%=14liters
1000mls bottle fills up with cooking oil in 127seconds

Results can show that the Simple Mobile Peanut Butter our can shell 81.2% groundnut with 20.07% damage. Groundnut Sheller machine capacity 130.5 kg per 1 hrs.

7.0 EXPECTED OUTCOME OF WORK

The outcome of the work undertaken will be a simple mobile Peanut butter/Cooking oil manufacturing Plant which will change the farming of people especially subsistence farmers who cannot afford to buy a groundnuts shelling machine and a peanut butter making machine to do their work faster and to quickly to supply.

8.0 CONCLUSION

Simple mobile manufacturing plant is better option to use for subsistence farmers instead of them to spend much time and money taking the ground nuts to the market the process is too much from one machine to the other, however with the plant all work is done within the same place, the use of its inconvenience it can move from one place to another by towing with castles we all know that at least a famer can have cattle's or a tractor as a tool of transportation. In addition too, cooking oil can also be produced within the manufacturing plant by not taking the groundnuts to the roasting stage which is the third stage in the process and there will be a need to change the grinding disc in order to crush up to oil which will helps to reduce the cost of productions. This machine also saves time to small scale farmers with Simple design, easy maintenance and high reliability of operation.

9.0 ACKNOLEDGEMENT

I would particularly like to single out my supervisor Dr. Oliver given to conduct my research and further my dissertation at ZRDC.
I would also like to thank my colleagues from ZRDC and ICUZambia for their wonderful collaboration. You supported me greatly and were always willing to help me. In addition, I would like to thank the Zambia Institute of Special Education for the provision of Internet for advanced Research. You definitely provided me with the tools that I needed to choose the right direction and successfully complete my dissertation. I would also like to thank my parents for their wise counsel and sympathetic ear. You are always there for me. Finally, there are my friends. We were not only able to support each other by deliberating over our problems and findings, but also happily by talking about things other than just my full paper. Thank you very much, everyone!

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ABOUT THE AUTHOR

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