Tapioca Harvesting Machine

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Abstract - Tapioca, a starch extracted from cassava root is cultivated around the hill stations. The cassava roots are very strong and it requires to be harvested assiduously when using hand. Large-scale harvesters have harvesting attachments attached to the tractor. But it may damage the cassava, so the design is proposed to make a harvesting machine which will harvest the cassava without any damage and to make an effective equipment available at nominal prices. The mission is to create a portable, user-friendly and low cost mini harvesting machine. The idea was to create a machine which is cheap and will reduce the labour required to harvest crops. This machine has the capability and the economic value for fulfilling the needs of farmers having small land holdings. The cost of harvesting using this harvester is considerably less as compare to manual harvesting. As a solution for these entire problems, we would like to introduce our project Tapioca Harvesting Machine.

***Key Words*: Tapioca Harvesting, Labour, Farm Equipment, Agriculture, Cassava, Manual harvesting**

1. INTRODUCTION

Cassava (Manihot esculenta) is the most widely cultivated root crop in tropics and is grown across a broad range of agro-climatic conditions. Tapioca is familiar crop which cultivated around Kerala and Tamil Nadu. It was harvested by using hand, it is very difficult to harvest crop so we decide to make harvesting machine which should be economical. Most of the Indian farmer's economic condition is not good, so they not able to buy tractor or large harvesting machines, so this kind of equipment's help them to harvest in low investment. It reduces the harvesting wages of farmers. It's a shrubby, tropical, perennial plant that is less common in the temperate zone. There is shortage of skilled labor available for agricultural purpose. Because of this shortage the farmers have transitioned to using harvestings. Cutting crop manually using labour but this method is very time lengthy and time consuming. Large scale harvesters have harvesting attachments attached to the tractor. But it may damage the cassava, so the design is proposed to make a harvesting machine which will harvest the cassava without any damage and to make effective equipment available at nominal prices. This machine is cost effective and easy to maintain and repair for the farmer. India acquires significant in the global tapioca scenario due to its highest productivity. About 90 percent of total tapioca area and production in India are confined Salem, Namakkal, Erode and Vilupuram district of Tamilnadu. An average productivity of tapioca is highest in the world.

Fig -1.1: Harvested tapioca

1.1 AIM & OBJECTIVE OF THE PROJECT

Smaller and efficient combine harvesting which would be more accessible and also considerably cheaper. The mission is to create a portable, user-friendly and low cost mini harvesting machine. The idea was to create a machine which is cheap and will reduce the labour required to harvest crops. This machine has the capability and the economic value for fulfilling the needs of farmers having small land holdings (less than 2 acres). This machine is cost effective and easy to maintain and repair for the farmer. Our ultimate aim to design and fabricate an efficient and cost-effective machine to harvest tapioca.

1.2 NEED OF THE PROJECT

Tapioca was harvested by using hand, it is very difficult to harvest crop so we decide to make harvesting machine which should be economical. Most of the Indian farmer's economic condition is not good, so they not able to buy tractor or large harvesting machines, so this kind of equipment's help them to harvest in low investment. It reduces the harvesting wages of farmers. It's a shrubby, tropical, perennial plant that is less common in the temperate zone. There is shortage of skilled labour available for agricultural purpose. Because of this shortage the farmers have transitioned to using harvestings. Cutting crop manually using labour but this method is very time lengthy and time consuming. Development of labour saving technology for tapioca harvesting becomes most critical challenge in tapioca transformation. The harvestings are available for purchase but because of their high costs, they are not affordable. The tapioca roots are very strong and it requires to be harvested assiduously when using hand. Large scale harvesters have harvesting attachments attached to the tractor. But it may damage the cassava, so the design is proposed to make a harvesting machine which will harvest the cassava without any damage and to make effective equipment available at nominal prices.

- Tapioca harvesting needs a lot of manpower and is also very time consuming process.
- Farmers in India are getting discouraged by the problems like high wages and insufficient number of labour.

This project aims to solve all the above mentioned issues.

1.3 NECESSITY OF HARVESTING EQUIPMENT

Cassava is cultivated eighty percentage in Tamil Nadu. It is majorly cultivated around namakkal, erode, Salem, Kanyakumari. It cultivate in 1.39 lakes hectares in Tamil Nadu. Most of the farmers are having below 2 hectares so they not using tractor for harvesting tapioca. They using daily wages peoples for harvesting it required more energy to harvest tapioca from field. Due to harvesting using daily wages people, wages for harvesting is accurse more it affect their profit. Existing model is an attachment which attached in tractor it damage the tapioca it affect its grade in market so we make this machine which harvest the crop without damaging the tapioca. So it help to increase their profit.

1.4 TECHNOLOGICAL DEVELOPMENT

Engineers at home and abroad have made many attempts towards the development of cassava uprooting devices. These include manual devices such as cutlasses and hoes and semi-mechanized devices such as Prairie mouldboard ploughs with different structural configurations such as:

- Inverting the whole ridge and roots with a mouldboard plough body
- Pulling a mouldboard share (with the board removed) below the soil level
- Using a mouldboard plough to split the ridge along the crest
- Pulling specially designed blades to cut below the tubers
- Using animal and tractor-drawn single disc ploughs to harvest tapioca

Further work on the machine led to the development of a single-row harvester with two gangs of reciprocating Power Take off driven diggers, which digs on two opposite sides of the ridge from the furrow bottom in order to uproot the Cassava root cluster. The combine harvester, or simply combine, is a machine that harvests grain crops. It combines into a single operation process that previously required three separate operations (reaping, threshing and winnowing). Among the crops harvested with a combine are wheat, oats, rye, barley, corn (maize), soybeans and flax. Notwithstanding the technological improvement so far, little has been done in the area of root crop harvesting. Traditionally, root crops are harvested using cutlasses, hoes, diggers, digger-pickers and by hand. It is now the most widely cultivated crop in Africa and is grown by subsistence farmers, who depend on seasonal rainfall. Cassava as a food crop helps in sustaining food security but efficient mechanical uprooting, storage and processing technologies need experts' attention Cassava is typically grown by small-scale farmers using traditional methods and can do well even on land that is not suitable for other crops. Cassava is propagated by cutting a mature stem into sections of approximately 15 cm and planting these prior to the wet season. The roots are harvestable after 6 to 12 months and can be harvested any time in the following 2 years. The most difficult operation in cassava production is cassava harvesting. The reasons being that Cassava is harvested by hand; in addition, there is the difficulty in the design of the digging blades because of the indeterminate shape and geometry of the tubers in the soil.

Manual harvesting of cassava involves the following steps:

1.	Plucking off the upper parts of the stems with the leaves before harvest.
2.	Cutting of the stem about 0.3 m above the soil surface and collecting the stems as planting material.
3.	The loosening of the soil at the cassava root zone.
4.	Lifting the cassava root system out of the soil and separating the root system from adhering soil before collecting tubers, loading them on to transport vehicles and transporting them as required.

Table-1.4 Manual harvesting

Existing manual harvesting techniques lead to drudgery, wastage and also consume a lot of time and farm labor, which is scarce and costly. Cassava harvesting is still done manually in Ghana, Nigeria, Thailand and other parts of the world. Manual harvesting of cassava does not fit well with the modern processing factories. This is as a result of the low productivity associated with manual uprooting of cassava. The cost of manual harvesting is high; it takes about 25 to 35 men days to harvest a hectare of cassava. One major challenge associated with this important food crop the world over, is difficulty in uprooting it. Currently, this is done manually by hands and consequently farmers develop blisters in their palms, callus palms, arched spinal cord and waste pains over time. Manual uprooting is slow with low output and productivity but an uprooting device will be faster with high productivity. It is against this background that an easy way of uprooting cassava locally is being considered in this paper. The objective of this paper is therefore to design a simple, efficient, cheap and affordable device to facilitate easy uprooting of cassava for local farmers.

1.5. CASSAVA IN INDIA

In India, the cultivation of cassava is mainly done in Kerala, Tamil Nadu, Andhra Pradesh, Nagaland, Meghalaya, Assam, etc. Tamil Nadu stands first both in area and production followed by Kerala and Andhra Pradesh. As per the second advanced estimates for the period 2012- 13, the total area under tapioca in India is 216.66 thousand hectares and the production is about 7319.13 thousand metric tonnes. Table shows data on area and production in different states during 2012-13. In Tamil Nadu and Andhra Pradesh, it is grown under open conditions whereas in Kerala about 40 per cent of cassava is raised as a mixed crop. About 40 per cent of cassava in Tamil Nadu is intercropped with short-duration crops such as cowpea, black gram, groundnut and vegetables. In Karnataka, it is grown along with areca, coconut and rubber. The mixed cropping system practiced in these states provides the much needed additional income to the small and marginal farmers.

State-wise Area and Production of Tapioca During 2012-13

(Second advance estimates)

State	Area ('000 hectares)	Production ('000 metric tonnes)
Tamil Nadu	109.56	4205.82
Kerala	72.47	2637.20
Andhra Pradesh	16.45	329.02
Nagaland	6.00	50.00
Meghalaya	5.60	30.05
Assam	4.48	38.31
Karnataka	1.00	12.90
Total (including others)	**216.66**	**7319.13**

Source: Ministry of Agriculture, Government of India

Table 1.5 Production of tapioca

2. LITERATURE REVIEW

[1] K.V.Hariharan, S.P.Pradepkumar, M.Prasanth (International journal of innovative research in science, volume 4, special issue 6, May 2015) Manual tapioca root tuber peeling rate of about 21.8kg/h, Ezekwe et design spring load tapioca peeling machine with 5 spring load point equal spaced at 140mm interval and length of knife assembly with spring 2.193 N/mm. Tapioca is in various sizes and average height stem to suit various tuber sizes, this result obtained is 15% broken tuber with peeling efficiency 98.8%. The rate of loading root diameter were found to have significant effect on the breaking strength, deformation of root, breakup energy.

[2] Shadwack kwadwo, Amponash and byju gongadharan (Review of various harvesting option for tapioca) Various mechanized harvesting option have been developed for the use in different part of world to overcome challenges. Earlier attempts at mechanizing tapioca scale of cultivation. Development of labour saving technology for the tapioca harvesting becomes most critical challenge in cassava transformation. Earlier attempts at mechanized harvesting have been affected by constrain such as soil characteristic, nature, size of tuber depth and both between tuber and soil leading to high tuber damage and root tuber breakage There by usage of pneumatic cylinder and the gripper in machine the chance of getting damage to tapioca get reduced.

[3] Shadrack Kwadwo Amponsah, J. Thajudhin Sheriff , Gangadharan Byju (1. CSIR-Crops Research Institute, Kumasi, Ghana; 2. ICAR- Central Tuber Crops Research Institute, Sreekariyam, India). The study sought to investigate the 13 effect of cassava agronomy parameters on uprooting force requirement. The field study was carried out at the central tuber crops research institute (CTCRI).

[4] Lawal N.S, M.Akinbamowo (Journal of innovative research, Volume5, issue 6, july2015) Planting were majorly being carried out manually mechanical planters available in fully developed to level for them to be taken up by fabricators for commercialization, the implementation of automatic and improved cultural practice of tapioca enhance for reduction of the labour and time.

[5] Asetifa B.O, Lawal N.S, Samuel T (Development on manually operated tapioca harvester using hydraulic medium). The aim of study is to design and develop low cost, light manually operated hydraulic tapioca harvester which would produce minimal disturbance to soil when harvesting. This study seek to eliminate high effort requirement in tapioca harvesting through use of hydraulic ram and plunger which will replace human arm lifting operation. There by pneumatic working will be more easier compared to hydraulic and it is appropriate to do the harvesting process.

[6] Akinbamowo R.O (Journal of agriculture and allied science, Volume-2, issue2, April-2013). The rate of harvesting of dug tapioca was determined with the machine running on the test field and designated PTO rotation with other selected operational and implement parameters (forwards speed and rake angle) for each row as plot layout, harvested tapioca are collected sown after harvesting, dug losses were determined by digging up tapioca and lift in soil per plot and machine has passed and surface produce collected labelled bugged and weighted.

[7] O.I Sekunowo,S.O Adesum and O.E ojo(International journal of engineering and technology volume 4,may 2014) tensile strength characteristics demonstrated by mild steel specimen after tempering, tensile behaviour steel austenised at 800 degree compared with 558.3 Mpa of other material. Emerging trending specimen's behaviour shows strength increase concomitantly with tempering temperature. Impact properties imperatives because fasteners are required to

exhibit adequate resistance to dynamic loading, susceptivity to brittle failure during installation.

[8] A.S. Akinwonmi and F. Andoh (Research Journal of Applied Sciences, Engineering and Technology 5(2): 411-420, 2013). This paper deals with a design of a cassava uprooting device. This study analyses the design of a simple, efficient, cheap and affordable cassava uprooting device for local cassava growing farmers. Processes involved in uprooting cassava were found out from local farmers, studied and mechanized using bevel gears, cams and followers, chain and sprockets. The principle of moments was used as a basis for the design.

3. METHODS OF TAPIOCA HARVESTING

3.1 MANUAL HARVESTING

This is the traditional method of harvesting cassava using a hoe, cutlass or mattock to dig round the standing stem to pull out the root before detaching the uprooted roots from the base of the plant. Figure shows two different manual cassava harvesting methods; one with the help of a cutlass and the other using a hoe. This method is laborious especially during the dry season when soil moisture is at lower levels. According to Nweke et al, manual harvesting requires about 22-62 man days per hectare.

Fig-3.1. Manual harvesting methods

3.2. SEMI-MANUAL HARVESTERS

The International Institute of Tropical Agriculture (IITA) in Nigeria designed and produced a manually operated cassava root tuber lifter to be used by small scale farmers for cassava growing areas in Africa The National Centre for Agricultural Mechanization (NCAM) in Nigeria also developed and commercialized a semi-mechanised cassava lifter/harvester as shown in Figure 5after Oni and Eneh . The IITA cassava lifter consists of a frame to which an immovable griping jaw is attached and a lever (handle) which is hinged to the frame for lifting cassava roots. The NCAM on the other hand, consists of a frame to which a footboard and immovable griping jaws are attached and a lever (handle) which is hinged to the frame.

Fig-3.2. NCAM cassava lifter

3.3 MECHANICAL CASSAVA HARVESTERS

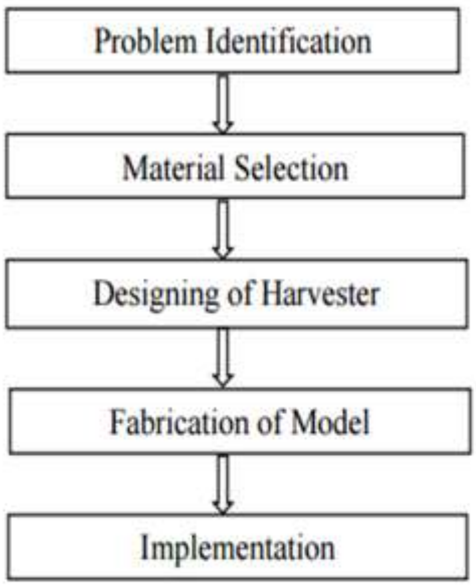
Leipzig Mechanical Cassava Harvester,the digging, lifting and transport of cassava root cluster into a windrow have been demonstrated under a Ghanaian condition using a prototype cassava harvester developed at the Leipzig University, Germany. The harvester reduces to the minimum the heavy physical work involved in manual cassava harvesting using the hoe and cutlass, especially in the dry season. Design goals for the Leipzig mechanical harvester prototype included: cutting of soil, digging of soil, raising of soil containing the cassava root cluster, transporting the cassava root cluster into windrow behind the tractor to ease manual tuber detachment from stem, reducing the number of moving parts, improvement in the flow of soil and residue to prevent blockade and fuel conservation during seedbed preparation for next cropping.

Fig-3.3. Leipzig Mechanical Cassava Harvester

Another mechanical harvester is TEK Mechanical Cassava Harvester as the name depicts, was developed and manufactured at the Department of Agricultural Engineering, Kwame Nkrumah University Science and Technology - Kumasi. The TEK mechanical cassava harvester basically has the following parts; digger, shakers consisting of a slatted mould conical mouldboard, the linkage points and the vertical support. The TEK 49 mechanical cassava harvester is a fully mounted implement which operates according to the „dig and pull" principle. When hitched to the tractor, after having met the required field conditions, the implement is lowered to set the required depth to dig (depending on root depth of the cassava variety to be harvested). The digger goes into the soil and then digs out the cassava root cluster. Due to the inclination of the slatted conical mouldboard (B), the roots are brought onto the surface for collection and detachment.

Fig-3.4. TEK Mechanical Cassava Harvester

4. METHODOLOGY



4.1. PROBLEM IDENTIFICATION

- It was very difficult to remove the soil and pull out tapioca
- More human labour is required for harvesting
- There is shortage of skilled labour available agricultural purpose
- Shortage of farmers has transitioned to using harvesting crop manually using labour but this method is very time consuming.
- There is chance of breaking of tapioca while pulling out from soil.
- Harvesting of tapioca manually requires more effort.

4.2. MATERIAL SELECTION

SL. NO	COMPONENTS	MATERIAL
1.	Frame	Mild Steel
2.	wheel	Mild Steel
3.	Bearing	Steel
4.	C-bracket & Arm	Mild Steel
5.	Gear wheel	Mild Steel

Table-4.2. Material Selection

5. COMPONENTS AND DESCRIPTION

The major components that are used in this project are as follows:

5.1. FRAME

The whole power is mounted on frame structure with suitable arrangements. Frame is made of mild steel. Boring of bearing sizes and open bores done in one setting so as to align bearing properly while assembling provision is made to cover the bearing with grease. Frame is the creation of metals structures by cutting, bending, and assembling processes. Frame is a value added process involving creation of machine parts and structures from various raw materials. Mild steel is type of carbon steel with low amount of carbon, it is also known as “low carbon steel” although ranges vary depending on source, the amount of carbon typically found in mild steel is 0.05% to 0.25% by weight. Whereas higher ranges from 0.30% to 2.0%. Mild steel is not an alloy steel and therefore does not contain large amount of other elements beside iron.

Fig-5.1. Frame

5.2. DC MOTOR

A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor. DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a light weight brushed motor used for portable power tools and appliances. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications. The DC motor is the device which converts the direct current into the mechanical work. It works on the principle of Lorentz Law, which states that "the current carrying conductor placed in a magnetic and electric field experience a force". And that force is called the Lorentz force.

Fig-5.2. DC motor

DC Motor Characteristics are runs on DC power or AC line voltage with a rectifier, Operating speeds of 1,000 to 5,000 rpm, 60-75% efficiency rate, High starting torque, Low no-load speeds.

5.3. WHEEL

A wheel is a circular component that is intended to rotate on an axial bearing. Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines. Wheel is designed and fabricate inspired from the wheels of tractors for the usage on loose soils and other unleveled surface.

Fig-5.3. Wheel

5.4. BALL BEARING

A bearing is machine element that constrains relative motion to only desired motion and reduces friction between moving parts. The bearings are pressed smoothly to fit into the shafts because if hammered the bearing may develop cracks.

Fig-5.4. Ball bearing

Bearing is made up of steel material and bearing cap is mild steel. Some types of bearings are roller bearing and ball bearing. The bearings are mainly used to reduce friction. The allow demand application to meet maximum efficiency, reliability, durability and performance. A ball bearing is a type of rolling element bearing that uses balls to maintain the separation between bearing races. The purpose of ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using atleast three races to contain the balls and transmit loads through the balls. The most application one race is stationary and other is attached to rotating assembly. As one of the bearing races rotates it cause the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces where sliding against each other. Radial ball bearing (6202) is able to accommodate low to heavy radial loads and low to moderate thrust loads in either direction. They are available with metal shields or rubber seals. Several tolerance grade, internal clearance and cage designs are available to best suit the running precision and speed of the application.

5.5. LEADSCREW

A leadscrew (or lead screw), also known as a power screw or translation screw, is a screw used as a linkage in a machine, to translate turning motion into linear motion. Because of the large area of sliding contact between their male and female members, screw threads have larger frictional energy losses compared to other linkages. They are not typically used to carry high power, but more for intermittent use in low power actuator and positioner mechanisms. Leadscrews are commonly used in linear actuators, machine slides (such as in machine tools), vises, presses, and jacks. Leadscrews are a common component in electric linear actuators. Leadscrews are manufactured in the same way as other thread forms (they may be rolled, cut, or ground).A lead screw is sometimes used with a split nut also called half nut which allows the nut to be disengaged from the threads and moved axially, independently of the screw's rotation, when needed (such as in single-point threading on a manual lathe). A split nut can also be used to compensate for wear by compressing the parts of the nut.A hydrostatic leadscrew overcomes many of the disadvantages of a normal leadscrew, having high positional accuracy, very low friction, and very low wear, but requires continuous supply of high pressure fluid and high precision manufacture leading to significantly greater cost than most other linear motion linkages.

Fig-5.5. Leadscrew

5.6. GEARWHEEL

A gear or cogwheel is a rotating machine part having cut teeth or, in the case of a cogwheel, inserted teeth (called cogs), which mesh with another toothed part to transmit torque. Geared devices can change the speed, torque, and direction of a power source. Gears almost always produce a change in torque, creating a mechanical advantage, through their gear ratio, and thus may be considered a simple machine. The teeth on the two meshing gears all have the same shape. Two or more meshing gears, working in a sequence, are called a gear train or a transmission.

Fig-5.6. Gearwheel

The gears in a transmission are analogous to the wheels in a crossed, belt pulley system. An advantage of gears is that the teeth of a gear prevent slippage. When two gears mesh, if one gear is bigger than the other, a mechanical advantage is produced, with the rotational speeds, and the torques, of the two gears differing in proportion to their diameters. Spur gears or straight-cut gears are the simplest type of gear. They consist of a cylinder or disk with teeth projecting radially. Though the teeth are not straight-sided (but usually of special form to achieve a constant drive ratio, mainly involute but less commonly cycloidal), the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears mesh together correctly only if fitted to parallel shafts. No axial thrust is created by the tooth loads. Spur gears are excellent at moderate speeds but tend to be noisy at high speeds.

5.7. SWITCHING RELAY

Typically they are used to switch light current loads, ranging from fan motors to damper controls. A relay is a device that acts as a remotely controlled switch. Relays used in control circuits of typical HVAC/R systems may be electromechanical. A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals.. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit.

Fig-5.7. Switching relay

5.8. BATTERY

A battery is a device consisting of one or more electrochemical cells with external connections for powering electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy.

Fig-5.8. Battery

5.9. VIBRATOR MOTOR

Vibration motor is a coreless DC motor and the size of this motor is compact. The main purpose of this motor is to alert the user from receiving the call by without sound/vibrating. These motors are applicable for different applications like pagers, handsets, cell phones, etc. The main feature of this motor is, it has magnetic properties, lightweight, and motor size is small. Based on these features, the motor performance is highly consistent. The configuration of these motors can be done in two varieties one is coin model and another one is a cylinder model. The vibrator motor specifications mainly include type, max operating torque, max. centrifugal force, weight range, rated current and output.

Fig-5.9. vibrator motor

5. WORKING PRINCIPLE

- The ultimate aim of the machine is to harvest tapioca without any leftovers underneath and make the process easy.
- The initial design consists of a four legged structure, with a basement and wheels attached to each leg.
- At the centre of the basement, there is an electric motor attached to a threaded rod by which, the arm moves up and down. This is to pull up the tapioca.
- Switching relay for driven the dc motor. Single contact relay for vibrator motor and double contact relay for motor in which function in up and fro of the arm.
- Along with this setup, there is a vibrator motor powerful enough to loosen the soil around the tapioca and a battery which powers this whole setup.
- It has a main platform in which its gear wheel, motor support , wheel and threaded support all are connected.
- The thread support is moving through a slotted support to and fro.
- Bottom of the threaded support is connected to a motor vibrator. To provide a vibration for arm.
- The C brackets are connected at the bottom of tapioca and the arm is tighten by a locking mechanism.
- The arm is adjustable and the motor vibrator is ON.
- It provide a vibration action around the tapioca and loosens the soil.
- The soil loosens and the threaded shaft move upwards with the help of a motor in connection with a gear wheel.
- On the process the tapioca gets detached from the soil.
- This process is carried out for harvesting tapioca using this machine.
- Wheels designed is inspired from the wheels of tractors for the usage on loose soils and other unleveled surface.

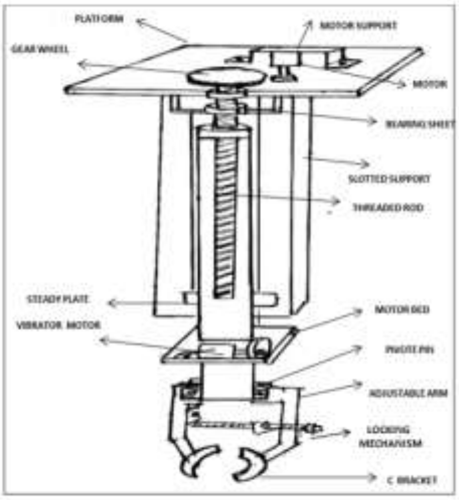


Fig-6.2. Basis mechanism

6. DESIGN

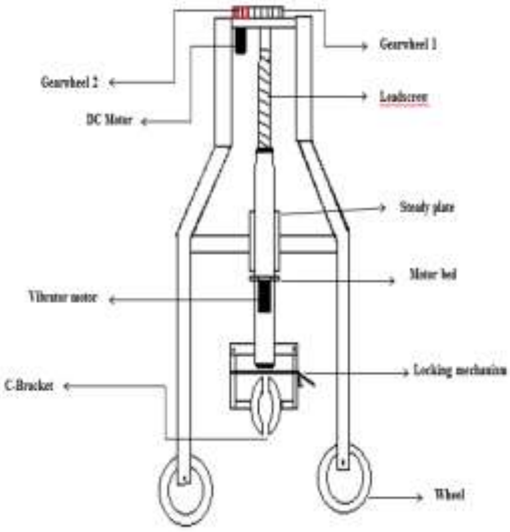


Fig-6.1. Structural view

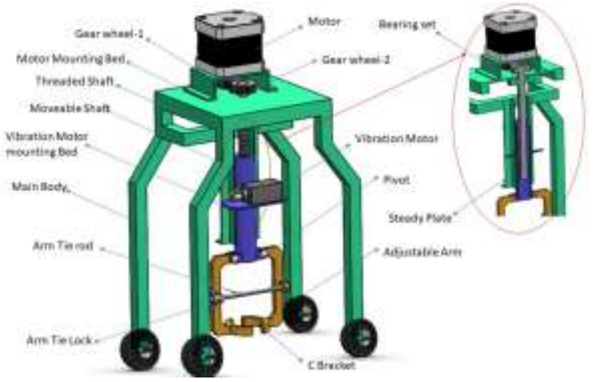


Fig-6.2. 3D Drawing

7. SPECIFICATIONS

7.1. LIFTING MOTOR

- Motor type = DC motor
- Volt = 24v
- Ampere = 30A
- Watts = 24×30=720watts
- RPM = 2500

7.2. VIBRATOR MOTOR

- Motor type = DC motor
- Volt = 12v
- Ampere = 50A
- RPM = 1500

7.4.3. GEAR WHEEL

- Type = Spur gear
- No. of teeth on driving gear = 8
- No. of teeth on driving gear = 90
- Material = Mildsteel

7.4. BALL BEARING

- Selection of Bearing = No.6202
- Outer Diameter of Bearing (D) = 35 mm
- Maximum Speed = 15,000 rpm
- Thickness of Bearing (B) = 12 mm
- Inner Diameter of the Bearing = 150 mm
- Material = Steel

7.5. LEADSCREW

- Material = Mildsteel
- No. of groove = 88
- Length = 46 cm
- Diameter = 20 mm
- Thread type = circular
- Pitch = 2 mm
- Screw shaft eff. dia. = 19 mm
- Screw shaft minor dia. = 17.18 mm
- Material = Mildsteel

7.6. BATTERY

- Volt = 12 v
- Ampere = 40 A
- Watts = 460 watts

7.7. WHEEL

- Material = Mildsteel
- Diameter = 22

8. CALCULATION

8.1. CALCULATION OF BALL BEARING

Selection of Bearing No. 6202
Outer Diameter of Bearing (D) = 35 mm
Thickness of Bearing (B) = 12 mm
Inner Diameter of the Bearing (d) = 150 mm
Radius (r_1) = 1
Maximum Speed = 15,000 rpm
Mean Diameter (dm) = (D + d) / 2
= (35 + 15) / 2
dm = 25 mm

8.2. CALULATION OF GEAR WHEEL

- Gear ratio =

$$\frac{\text{No. of teeth of driven gear}}{\text{No. of teeth of driving gear}}$$

No. of teeth of driven gear = 90
No. of teeth of driving gear = 8

Gear ratio = 11.25.

As we know that specification of motor ,i.e.,speed = 2500, Torque = 15 Nm

- S1× No. of teeth of driven gear = S2× No. of teeth of driving gear

$$\frac{S1}{S2} = \frac{\text{No. of teeth of driven gear}}{\text{No. of teeth of driving gear}} =$$

$$\frac{2500}{S2} = \frac{90}{8}$$

$$S2 = (2500 \times 8) \div 90 = 222 \text{ rpm}$$

Where, S2 is the speed of driven gearwheel and S1 is the speed of the driving gear wheel.

- Gear ratio $= \frac{\text{Torque output}}{\text{Torque input}}$

$$11.25 = \frac{\text{Torque output}}{15}$$

$$\text{Torque output} = 11.25 \times 15 = 168 \text{ Nm}$$

The torque produced by the driven gear is 168 Nm

- Gear efficiency $= \frac{\text{Power output}}{\text{Power input}}$

$$\text{Power input} = \frac{2\pi N_1 T_1}{60} = \frac{2\pi \times 2500 \times 15}{60} = 3927 \text{ watts}$$

$$\text{Power output} = \frac{2\pi N_2 T_2}{60} = \frac{2\pi \times 222 \times 168}{60} = 3906 \text{ watts}$$

$$\text{Gear efficiency} = \frac{3906}{3927} = 0.99$$

The efficiency of gear wheel is 0.99.

8.3. WEIGHT LIFTING CALCULATION

Experiment checking around 10 harvesting of tapioca plant with the instrument spring balance. From the experiment for harvesting tapioca plant mass required for harvesting each plant were 132 kg , 127 kg , 98 kg , 86 kg , 102 kg , 98 kg , 101 kg , 70 kg , 108 kg , 92 kg.
Taking average mass = 101.4 kg

From the force of gravity, F = Mg
Where, M = Mass of tapioca
g = Force of gravity
Average mass = 101.4 kg
Force of gravity = 9.81
F = 101.4*9.81 = 995 N

- Workdone in lifting a 995 N weight, .5m off the ground.
  W = Force*Distance
  W = 995*.5
  = 497 Nm 0r Joule
- Power required for lifting tapioca in 2 Minutes.

We know that, Power $= \frac{\text{Work}}{\text{Time}} = 4.14$ watts

Power required for lifting 101.4 kg of tapioca in 2 min is 4.14 watts.

9. FABRICATION PROCESS

- MS square pipe of 30mm is cut as in the dimension as in above figure.
- MS square pipe pieces which has cut is welded together to develop a leg, similarly 3 legs also fabricate.
- Finally weld the legs of the frame together to fabricate frame of the machine.
- MS round pipe of diameter 7.5cm and height 62cm is taken as the arm support, with the help of MS flat of 3*30mm and square pipe of 30mm for the c-bracket, arm and locking mechanism.
- MS rod of 30mm for the fabrication process of leadscrew ,no of groove in the leadscrew is 88.
- Attachment of bearing and gear wheel to the leadscrew. No of teeth on the gearwheel is 90 and the 6202 bearing is selected.
- Cut 3 pieces of MS flat of 6*65mm of dimension 15cm which is attached to the leadscrew and also to the frame.
- Attachment of leadscrew to the arm of the product.
- Motor is connected to the gearwheel, on motor gear there is 8 number of teeth.
- Vibrator is attached to the supporting plate on the arm of the product.
- Wheel is designed and fabricate inspired from the wheels of tractors for the usage on loose soils and other unleveled surface.
- Steady plate is fabricate which gave support to the arm when vibration and rotation of motor taken place.
- Finally provide electrical connection to vibrator and motor by switching relay, power supply taken from a battery.
- At last the product tapioca harvesting machine is fabricated and ready for the testing.

Fig-9.1. Proposed machine

10. ADVANTAGES

- Separate tapioca from soil and collect in ridge, easy to load.
- Manual power not required.
- Maintenance is easy.
- Replacement of parts is easy.

- The involvement of manual work is highly negligible.
- Simple in construction.
- High efficiency.
- No need of skilled operators to operate this system.

11. APPLICATIONS

- It is used in the agricultural fields.
- It is used in ground seed harvesting.
- Arm can be used for up lifting heavier objects.

12. BENEFITS

- Less energy expended .
- Increase in the number of Cassava roots uprooted .
- Saving time.
- Reduction in the risk of health hazards of developing blisters in the palms, callus palms, arched spinal cord and waste pains over time.
- Higher output and productivity.
- Enhancement in the easy way of uprooting Cassava.

13. RESULT

After complete the machine, it was taken into agricultural field and test the entire performance of the equipment. The experiment had been done at a tapioca field, Elanji grama panchayath, Ernakulam district. During this experiment 5 tapioca plants were harvested by using manual method and other 5 tapioca plants were harvested by using the tapioca harvesting machine. It has been observed that:

Manual Method	Proposed Machine
During harvesting 20% waste occurs that means some part of the tapioca remains in the soil.	During harvesting 5% waste occur that means we can completely pull out the tapioca without any damage
Time consuming, it takes 30min for harvesting 5 tapioca plants.	Less time consuming, it takes 20min for harvesting 5 tapioca plants.
High man power required.	Less man power required.
High labour cost required	Less labour cost, i.e the field owner can be harvesting using this product without depend on labours.

Table-13.1. Result observed comparison with manual harvesting and our product

14. CONCLUSION AND FUTURE WORK

Tapioca harvester is simple compact structure and can operate easily. This unit is equipped with a wheeled frame as its supporting power. The tapioca stem would be higher of the ground so that the combined operation of both digging and plucking are performed in one stroke. If the digging depth is adjusted other deep rooted crops like cassava have also be harvested. The digging part and frame can be adjusted according to any tapioca fields. No tapioca root breakage was observed during the harvesting procedures and giving the high lifting efficiency. Many ways of reducing the production costs must be investigated to make the study more appealing to the rural farmers. We have implemented an automatic and improved cultural practices of tapioca harvesting machine that will enhance for the reduction of labour charge and time. Further improvements can also be made regarding the gripper size and mode of transportation. It is done by designing a portable machine which uses a powerful vibrator motor. The vibrator loosens the soil around the plant and pull it up without any of it getting stuck under the soil. Smaller and efficient combine harvesting which would be more accessible and also considerably cheaper. The mission is to create a portable, user-friendly and low cost mini harvesting machine. The idea was to create a machine which is cheap and will reduce the labour required to harvest crops. This machine has the capability and the economic value for fulfilling the needs of farmers having small land holdings. This machine is cost effective and easy to maintain and repair for the farmer.

The future work for this design by providing better c bracket or gripper for lifting heavier objects. It is used in ground seed harvesting. The device is recommended to the Cassava growing farmers to enhance and enjoy the benefits. This designed is limited to lose to moderately loose and moist soil, it is therefore pertinent that further research work be carried out to make the design applicable to other types of soil structures.

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