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DOMESTIC GINGER WASHER

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Abstract: The Ginger producer farmers face a lot of issues from cultivating the crops to selling it in market. One of the major issues faced by the farmers is to remove soil stuck on the cultivated ginger or turmeric.
It needs a large water source to wash all the material which is most frequently not available and even if the water source is available, it requires a lot of efforts and time to clean all the material and also some parts of ginger or turmeric get wasted during this process.
The soil removed from ginger and turmeric is settled down on the banks of river which is also harmful for peoples or animals. If the layer of loosen soil is continuously settled on the bank of river or lake its very dangerous for animals to go on river or lake to drink water, they can be stuck in mud.
To resolve this problem, we first took the survey of farmers what are the problems they actually facing during all these processes of washing, how much amount is spent for washing and transportation of raw material. After studying and analyzing farmers needs and problem we came with the mechanism which will remove all the soil stuck to the ginger in the farm itself.
Main advantages of the presented system are there is no wastage of soil, the soil from the farm remains in farm itself, it reduces human effort, minimize the time and cost required for washing and transportation.

I. INTRODUCTION

India is an agricultural country. About 70% of our population depends on agriculture. One-third of our national income comes from agriculture. Our economy is based on agriculture. Though we are developing country, we are not using technologies to improve our agriculture. So, we have to fabricate some machines which can be helpful to farmers so as to increase their profit, production and to save their time.

Present scenario in agricultural field in India related to cleaning and washing of turmeric and ginger is that farmer need to go on the bank of river or lake for washing to remove extra soil. According to idea in our project we are making a small unit that will wash the turmeric and ginger easily in the farm itself there is no need to go at the river or lake for washing.
Main advantages of the "**Domestic Ginger washer"** is there is no wastage of soil in farms it remains in farm itself, saves famers money which is required for transportation and washing, reduces human effort and also time is reduced.

1.1 Problem Statement: -

- During cultivation of ginger, after pulling out from the soil, ginger needs to be washed with water. For this purpose, large water source is required which is only available at the rivers or lakes.
- So, all the ginger cultivated needs to bring at the bank of river to wash it and then send it to the market.
- Also, a lot of energy and efforts required by the workers to wash ginger at the bank of river and a lot of ginger pieces get wasted in water during washing.
- Large number of capital cost and time gets wasted during this process.
- To avoid this waste of time and money we are going to manufacture a machine which completes washing of ginger at the farm itself.

1.2 Objective:

- To reduce human efforts.
- Reduces the risk of life of farmers and animals.
- Soil in farm remains in farm itself no wastage of soil.
- Prevent wastage of ginger and turmeric.
- To bring the technology and automation in the agriculture field.
- To save the valuable time and money of farmers.
- To increase the production rate and profit of farmers.

1.3 Scope: -

- To design **"Domestic Ginger washer** "of a high quality, easy to transport, light weight as much as possible, highly durable and easy to use at low cost.

II. SURVEY OF FARMERS

- **Cost estimation of ginger washing by using traditional method.**
  - Washing cost per kg = 1.5 Rs
  - Time required for washing per ton = 2-3 hrs.
  - Transportation time = 2 hrs.
  - Transportation cost per ton = 200 Rs

Tabular evaluation of cost required in different areas of ginger washing by traditional method.

Farmers Name	Land (Acre)	Production In (Ton)	Trans. Cost	Labour Cost	Washing Time (hour)	Total Cost
Shrirang Deshmukh	2	5	1000	7500	12.5	8500
Kamlakar Deshmukh	5	12	2400	18000	22	20400
Pravin Bhosale	3	6	1200	9000	13	10200
Lakhan Bhosale	1.5	2	500	3000	6	3500

.Cost analysis by traditional method

Following are some live images captured during the survey of washing of ginger at the bank of lake by traditional method:

Fig. No. 2. Tradional way of ginger washing

III. DESIGN CALCULATIONS

3.1 Design Calculation:

Weight Of Ginger = 50kg = 50 x 9.81 = 490.5 N

Adding 20% More weight for safety of Design = 490.5 + 490.5 x $\frac{20}{100}$ = **588.6 N**

3.2 Design of Drum:

Selection of Material:-

Galvanized Steel Sheet (GI Sheet)

The most important property required is corrosion resistance and good Formability

Permissible yield strength (σ) = 500 Mpa

Thickness of sheet = 1mm

Volume Of Ginger:

Length = 110mm

Width = 70mm

Thickness = 25mm

Volume of 1 piece = length x width x thickness

= 0.11 x 0.07 x 0.025 m = 1.925 x 10^{-4} m^3

Average weight of 1 Ginger = 80gm

There will be approx. 750 pieces in 60kg

Total Volume = 1.925 x 10^{-4} m^3 x 750 = **0.1443 m^3**

Assume volume of drum is to be $\frac{1}{6}$ x volume of ginger

Diameter and length from volume of Ginger and Drum

Vd= 6 x Vg = 6 x 0.1443 = 0.87 m^3

Vd = $\pi r^2 h$ = π x r^2 x 6r … (h = 2.25d)

r = 0.36m

d = 072m

Length = 2.25 x d = 2.25 x 0.72 <u>L = 1.62m</u>

Diameter and Length From Discharge

Q = $\frac{0.1443 \times 6}{5 \times 60}$ Q = 2.886 x $10^{-3}$$m^3$/s

Q = A x V = $\frac{\pi}{4}$ $\times d^2$ x $\frac{L}{t}$ = $\frac{\pi}{4}$ $\times d^2$ x $\frac{3d}{5\times 60}$

$d^3 = \frac{2.88 \times 10^{-3} \times 4 \times 300}{\pi \times 3}$

d = 0.716m take d = 0.72m

Length = 2.25d = 2.25 x 0.72 = 1.62m

Circumference of drum = 2πr = 2 x π x 0.36 = 2.26m

Volume Of metal sheet = C x L x Thickness = 2.26 x 1.62 x 0.0015 = 3.66 x $10^{-3}$$m^3$

Weight of metal sheet = Volume x Density = 3.66 x 10^{-3} m^3 x 7850 = **29 kg**

Design Of Skelton:-

Horizontal Strips:

L=1.62m,

W=0.03m,

T=0.003m,

No. of strips = 3

Total Volume of circular Strips = L x W x T x N = 1.62x 0.03 x 0.003 x 3 = 4.374 x 10^{-4} m^3

Circular strips:

L= 2.26 m,

W= 0.04 m

T= 0.003 m

No. of strips= 4

Total Volume of Circular Strips = 2.26× 0.004× 0.003× 4 = 1.084 x $10^{-3}$$m^3$

Total Volume of Skelton = 1.084 x 10^{-3}+ 4.374 x 10^{-4} = 1.52 x 10^{-3} m^3

Weight of Skelton = Volume x Density = 1.52 x 10^{-3} x 7850 = 12 kg

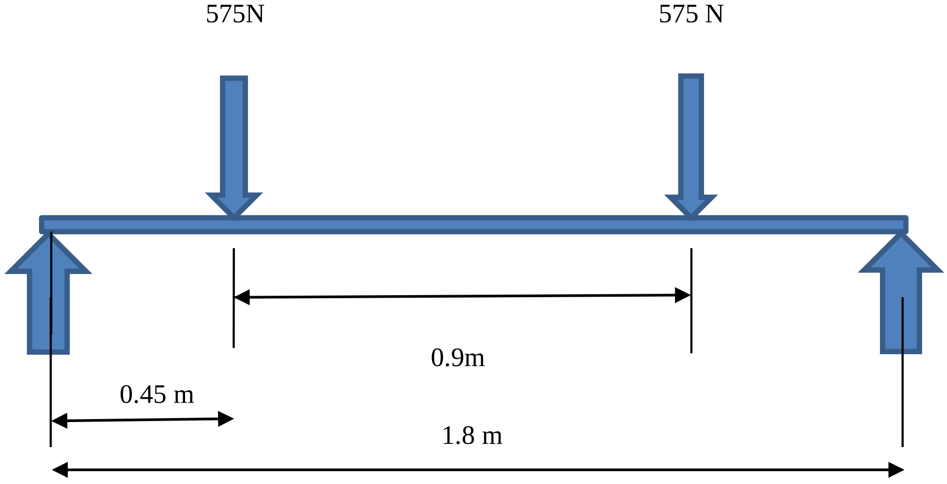
Total Weight = Ginger weight + Drum weight + Skelton weight + links & rings Weight = 60 + 29 + 12 + 14 = 115 kg

Add 7kg as weight of water

Total Weight = 125kg

Total Force = Total Weight x Gravity = 115 x 10 = 1150 N

3.3 Design of Shaft:-



$R_A + R_B = 1150$

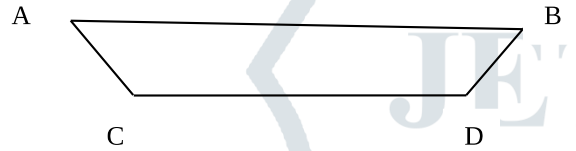
$R_A = 575$ N, $R_B = 575$ N

$\sum M_A = 0$

$\sum M_B = 575 \times 0.45 = 259$ Nm

$\sum M_C = 575 \times 1.35 - 575 \times 0.9 = 259$ Nm

$\sum M_D = 0$



259 Nm (Maximum Bending Moment)

Maximum bending moment=259 Nm , M=259 Nm

Velocity of drum:

RPM Of drum=30 rpm

Ɯ=Rpm/60×2π =30/60×2π =3.14 m/s2

Linear Velocity(N)=Ɯ×r =3.14×0.36 =1.13 m/s

Power(P)=Force × Velocity =1150×1.13 =1300 W

Consider 30% factor of safety in power

Power(P)=1300 + 1300 × 0.3 =1690 W = 2.5 HP

P=2πNT/60

1690=2π×30×T/60

T=1837×60/2π×30

T=593 Nm

For Material 40C8

τ max = 60 mpa σbmax = 90 mpa

Values of Kb & Kt from ASME codes for gradually applied load as follows :

Kb = 1.5

Kt = 1

$Te = \sqrt{Kb \times M^2 + Kt \times T^2}$

$= \sqrt{1.5 \times (259 \times 10^3)^2 + 1 \times (593 \times 10^3)^2} = 672.51 \times 10^3$Nmm

$Te = \frac{\pi}{16} \text{ x } \tau \text{ x } d^3$

τ = 60Mpa (Cast steel Grade 200 – 400 N)

$Te = \frac{\pi}{16} \text{ x } \tau \text{ x } d^3$

$$d^3 = \frac{672.51 \times 10^3 \times 16}{\pi \times 60}$$

d = 38.50 mm

$Me = Kb \times M^2 + \sqrt{Kb \times M^2 + Kt \times T^2}$

$= 1.5 \times (259 \times 10^3)^2 + 672.51 \times 10^3 = 1.06101 \times 10^6$Nmm

$Me = \frac{\pi}{32} \times \sigma \times d^3$

$d^3 = \frac{1.06101 \times 10^6 \times 32}{\pi \times 90}$ d = 49.80 mm

Shaft diameter from rigidity basis

We know that, $\frac{T}{IP} = \frac{G\theta}{l}$

$\frac{593 \times 10^3}{\frac{\pi}{32} \times d^4} = \frac{80 \times 10^3 \times 0.016}{1.8 \times 10^3}$………$(\theta = 0.016 rad)$

d = 53.98 mm ……..(Larger diameter value is selected)

Providing 1.1 as a factor of safety for adding keyways on shaft.
d = 53.98×1.1   d = 60 mm

3.4 Design of coupling :-

Following standard proportions are used in the design of flange coupling:

Outer diameter of hub, D = 2 d
Pitch circle diameter of bolts, D_1 = 3 d
Outer diameter of flange, D_2 = 4 d
Length of the hub, L = 1.5 d
Core diameter of bolt dc
Thickness of flange, t_f = 0.5 d
Thickness of protective circumferential flange, t_p = 0.25 d
where d is the diameter of shafts to be coupled.

Available data:

Torque (T) = 593x10^3 N.mm
Diameter of shaft = 60 mm

1.Design of hub:

Outer diameter of hub (D) = 2 d = 2x60 = 120mm
Length of the hub (L) = 1.5 d = 1.5x60 = 90 mm
Checking in shear:

K= $\frac{d}{D} = \frac{60}{120} = 0.5$

T = $\frac{\pi}{16}$ x D^3x (1- k^4) x τ

593x10^3 = $\frac{\pi}{16}$ x 120^3x (1- 0.5^4) x τ

τ = 1.46N/mm^2< 60 N/mm^2 (**Design is safe**)

2. Design of key:

Width =$\frac{d}{4} = \frac{60}{4}$ = 15 mm

Thickness = $\frac{d}{6} = \frac{60}{6}$ = 10 mm

Length = 1.5D =1.5x120= 180 mm

3.Deign of flange:

Thickness of flange (t_f) = $\frac{d}{2} = \frac{60}{2}$ = 30 mm

Checking in shear:

T = π x D x t_f x τ x $\frac{D}{2}$

593x10^3= π x 130 x 30 x τ x $\frac{120}{2}$

τ = 0.68<60 N/mm^2 (**Design is safe**)

4.Design of bolts:

Material: **C40**
For C40 τ = 40 N/mm^2
N = 4 for 40 <d(65) < 100mm
Pitch circle diameter of bolts (**D_1**) = 3d = 3 x 60 = 180mm

T = $\frac{\pi}{4}$ x dc^2 x N x τ x $\frac{d1}{2}$

593x10^3= $\frac{\pi}{4}$ x dc^2 x 4 x 40 x $\frac{180}{2}$

dc = 7.24 mm dc = 0.84do
do = 9 mm
Outer diameter of flange **D_2** = 4 d = 4 x 60 = 240mm
Thickness of protective circumferential flange = 0.25 d = 15mm

3.5 Design of bearing: -

Technical Specification: -

d	60mm	Bore diameter
D	95mm	Outside diameter
B	18mm	Width
d1	≈71.3mm	Shoulder diameter
D2	≈86.5mm	Recess diameter

da	min.66 mm	Diameter of shaft abutment
Da	Max. 89 mm	Diameter of housing abutment
ra	Max. 1 mm	Radius of shaft housing fillet

Calculation Data: -

Basic dynamic Load rating	C	30.7 KN
Basic static load rating	CO	23.2 KN
Fatigue load limit	Pu	O.98 KN
Reference speed	-----	15000 r/min
Limiting speed	-----	9500 r/min
Minimum load factor	Kr	0.025
Calculation factor	Fo	15.6

Mass: -

Mass Bearing	0.41kg

Tolerance Class: -

Dimensional tolerances	P6
Radial run-out	P6

Shaft subjected to pure radial force.
Total radial force (P) = Total force + Weight of shaft = 1150 + 45 =1600 N
Life (hrs) =2, 00,000hrs
n = 40 rpm
d = 60 rpm
L10 = $\frac{60 \text{ n life}}{10^6}$
= $\frac{60 \times 40 \times 2,00,000}{10^6}$ = 480 million revolution
Dynamic load carrying capacity
C = P × $(L10)^{\frac{1}{3}}$ = 1600 × $(480)^{\frac{1}{3}}$ = 12527.57 N
∴ Selecting the bearing having smallest difference in dynamic load carrying capacity.
∴ Bearing **6012** is selected.
Width = 18 mm
Outer Diameter = 95 mm
Inner Diameter = 60 mm

3.6 Design Procedure for Vibrating Screen: -

Rectangular Frame: - (Length)1.2 X 0.6(Width)
Material = Mild Steel
Total length of the square frame = 6m
Density of mild steel = 7850 kg/kg^3
According to Tata steels Barouche for 40 X 40 mm hollow pipes, weight is 2.2kg/m
Weight of rectangular frame = 2.2 X 6 = 17.52 kg

Side Plates:-
Material: _ Galvanized Steel
Density:-7850 kg/ m^3
Length = 1.2m + 1.2m + 0.6m = 3m
Width of each plate = 0.1m
Thickness of each plate = 0.0015m
Total Weight of plates = L X B X T X Density = 3 X 0.1 X 0.0015 X 7850 = 3.53 kg
Total Weight of Rectangular side Plates = 3.53 kg

Rectangular Sheet: -
Material = Galvanized Steel
Density = 7850 kg/ m^3
According to design standards for sheet, Thickness is equal to whole diameter.
Our requirement for hole diameter is 3mm
So thickness of sheet is 3mm.
Total weight of sheet = volume X Density = 1.2 X 0.6 X 0.0015 X 7850 = 8 kg
Total Weight of sheet = 8 Kg
Total Weight on the Motor = wt. of sheet + wt. of side plates + wt. of Frame + Weight of ginger = 8 + 3.53 + 17.52 + 50 = 79 kg
Total Weight on the motor is 79kg

3.7 Motor Selection: -

Total weight to be lifted = 790 N
Speed = 2800 rpm
Assuming shaft radius = 5 cm
Speed in m/s = 1.46 m/s
Power (W) = Weight × Speed = 790 × 1.46 = 1153.4 Watt

We need to convert power in HP.

∴Power (HP) = $\frac{1153.4}{745}$ =1.5 ∴we need to select **1.5 HP 2800 rpm** Vibrating Motor.

Weight of motor = 18 kg

Total weight coming on springs = 79 + 18 kg = 97 kg

3.8 Design of Spring : -

Load on spring = 970 N

Deflection = 5 mm

Spring index = 5

Material = Carbon Steel

Shear stress = 300 N/mm^2

G = 79 Gpa

Static Load = Static × Frequency of oscillations (F)

F = $\frac{\omega}{2\pi}$

ω =$\frac{rpm}{60}$ = $\frac{700}{60}$

F = $\frac{11.6}{2 \times 3.14}$ = 1.75

Dynamic Load = 970 × 1.75 = 1700 N

Now,

w1=970 N

w2 = 1700 N

w = w1 - w2 = 1700 – 970 = 730 N

Consider design stress 25% excess of permissible stress

∴ Shear stress = 1.25 × 300 = 375 N/mm^2

G = 80 × 10^3

K = $\frac{4c-1}{4c-4} + \frac{0.615}{c} = \frac{4 \times 5-1}{4 \times 5-4} + \frac{0.615}{5}$ = 1.31

Z = K × $\frac{8\, w\, z\, c}{\pi \times d^2}$

3.75 = 1.31 × $\frac{8 \times 1700 \times 5}{\pi \times d^2}$d = 8.69 mm = 9 mm

C = $\frac{D}{d}$

D = 5 × 9

D = 45 mm

Ƌ = $\frac{8\, w\, n\, D^3}{G\, d\, Y}$

5 = $\frac{8 \times n \times 45^3}{80 \times 9 \times 10^3}$ n = 5

For square & grounded end

n’ = n + 2 = 5 + 2 = 7

Ls = n’ × d = 7 × 9 = 63 mm

Ƌ max = 11.64 mm

*l*F = n’ d + Ƌ max + 0.15 Ƌ max = 63 + 11.64 + (0.15×11.64) = 76.386 mm

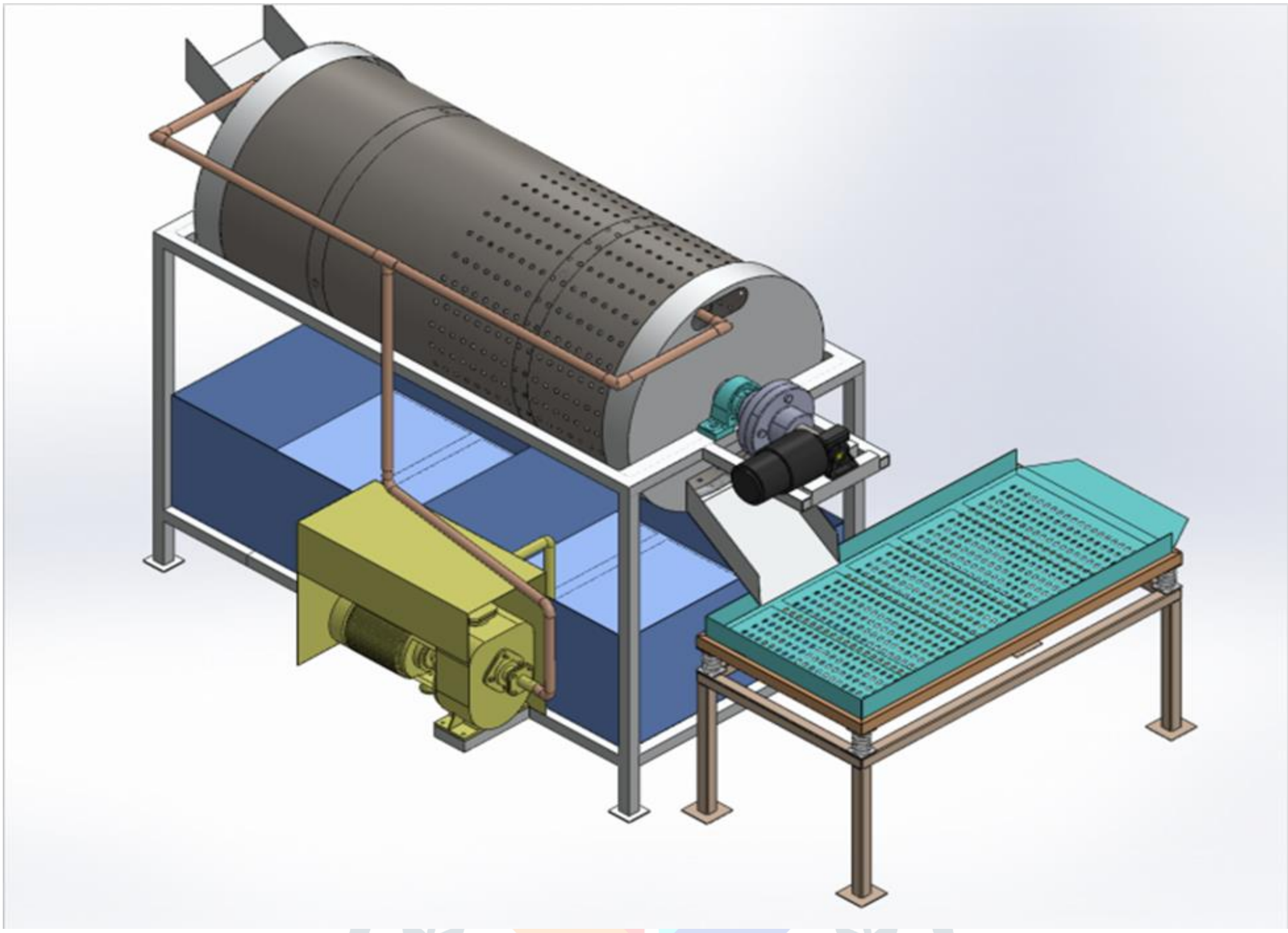
Pitch = $\frac{lF}{n'-1}$ Pitch= $\frac{76.386}{7-1}$

Pitch = 12.73 mm

3.9 Water pump selection: -

S. No.	Pump Model	Power Rating		Pipe Size (mm)		Full Load Current	Rated Voltage	Head in meter			
		kW	HP	SUC.	DEL	(Amps)	(Volts)	3	6	9	10
1	TINY	0.18	0.25	19	19	2	230	1600	1300	1100	1008
2	PEARL	0.37	0.5	25	25	2	210	-	2250	1944	1872
3	JALRAAJ-0.5	0.37	0.5	25	25	2	220	-	1800	1584	1512
4	CHHOTU	0.37	0.5	25	25	2	220	-	1980	1692	1620
5	WONDER III	0.37	0.5	25	25	3	210	-	1930	1705	1584
6	STAR	0.37	0.5	25	25	2.6	240	-	2700	2376	2250
7	GALAXY	0.37	0.5	25	25	2.6	240	-	2700	2376	2250
8	POPULAR LV	0.37	0.5	25	25	2.6	180	-	2700	2160	2061
9	MINI-28S*	0.37	0.5	25	25	3.4	210	-	3150	2808	2745
10	WAVE	0.37	0.5	25	25	3.4	240	-	2450	2232	2160

3-D Ginger Washer Design:



IV. COST ANALYSIS

Sr. No.	Part	Qty.	Rate	Material	Cost
1.	Drum	1	94	GI Sheet	3854
2.	shaft	1	65	Carbon Steel 40C8	2600
3.	Bearing	2	1300	Stainless Steel	2600
4.	Coupling	1	5000	Cast Iron	5000
5.	Geared Motor	1	18500	…..	18500
6.	Bearing Housing	2	1480	Cast Iron	2960
7.	Base Frame of Drum	1	70	Mild Steel	5600
8.	Vibrating Screen sheet	1	94	GI Sheet	752
9.	Vibrating Screen Frame	1	70	Mild steel	3000
10.	Vibrating motor	1	11500	----	11500
11.	spring	4	800	Carbon steel	3200
12	Kirloskar chotu pump	1-	2800	----	2800
13	PCV pipes	4	200	PVC	800
14	Water tank(300lit)	2	3000		6000
15	nozzle	6	120	brass	720
16	Manufacturing cost				15000
				TOTAL	**84886 Rupees**

Operational cost of ginger washer:

- Washing of ginger by using ginger washer

Formula for power consumption of single-phase motor is =
(Gear motor + Vibrating motor + Water pump)
Kwh = $(v \times I \times PF) \div 1000$
PF = Take power factor as 1

∴ Gear motor $= 2.5$ HP $\times 746 = 1867.5$ watt
Vibrating motor = 1.5 HP $\times$ 746 = 1119 watt
Water pump = 0.5 HP $\times$ 746 = 373 watt
Kwh = (1867.5+1119+373)$\div 1000$ = 3.3595 Kwh = **3.5 Units**

∴ For ginger washer 3.5 units of electricity are required per hour.
Consider cost of 10 Rs per unit

2 Labors required for ginger washing

∴ Labor cost = 500 × 2 = 1000 Rs
Transportation cost of ginger washer = 1000 Rs

Farmer Name	Total cost by traditional way	Total cost using ginger washer	Time for washing by traditional way(hour)	Time by using ginger washer (hour)	Cost saved
Shrirang Deshmukh	8500	2290	12.5	8 hr 15 min	6210
Kamalakar Deshmukh	20400	4200	22	20	16200
Pravin Bhosale	10200	2600	13	10	7600
Lakhan Bhosale	3500	1580	6	2.5	1920

Cost Comparison

V. FUTURE SCOPE

- In today's era of automation, there is large demand of automation in the agriculture industry which is the only field lagging in the automation.
- To get the work done in less time as well as in least cost will always be prior choice of all the farmers.
- In future, there may be chances of drying out rivers due to non-predictable climate conditions so, by using our project farmers no need to depend upon the weather or climate conditions for washing of ginger at the bank of river.
- To bring more automation we can add sensors to the vibrating screen so as the idle time of vibrating screen when ginger is in washing phase, will be reduced by providing sensors on the vibrating screen so as soon as the ginger pieces starts falling on the vibrating screen, then only the motor gets started and vibrating screen starts vibrating due to which more energy saving can be carried out and cost of washing can be reduced.
- We can also add packing system at the end of vibrating screen so that the worker required at the end of vibrating screen to collect the washed ginger can be eliminated and no need to carry out separate packing process for packing of ginger after washing due to which packing time can also be reduced.
- We can also add wheels and suspensions system to our project so that it will be directly attached to tractor and no need to carry into trolley.

VI. CONCLUSION

- Thus, using the "Domestic Ginger washer" for agriculture would make the heavier tasks much easier one and also prevents wastage of soil and human energy.
- By using the machine farmer can start his own business. After purchasing it farmer can start giving on rent to other farmers.
- By using this machine, we can exponentially reduce the labor cost to greater extent, about 70 to 80% labor cost can be reduced.
- Transportation cost required for carrying the ginger to the bank of river will be totally eliminated and the time gets wasted for this transportation also be saved.
- This machine also helps to prevent wastage of ginger and turmeric while washing process thus the weight of final product is not reduced.

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