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Advancement in Onion Harvester

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***Abstract*— Onion is one of the most important crop in India. The harvesting of onion crop is a labour intensive operation if a farmers gets workers for manually harvesting the onion crop is costs him about 7000Rs per acre.**

The present research work has been carried out to bring out the reliable solution for harvesting of onion crop. The harvesting of onion crop is a labour intensive operation. The attempt has been made to design the harvester for the low power capacity tractors range in the 15 to 20 hp. The size of the harvester has been decided with respect to the agro technical features of the crop.

The various designs of onion harvester are available in market but none of them have provided a fully reliable solution to farmers. So in this project we are going to design and manufacture the onion harvester so as to fulfil the demands of Indian Farmers. The harvester manufactured should be cost effective as well as increase the productivity, which would lead to increase in the profit of farmers.

***Keywords*— Onion crop, harvestor, tractors, productivity**

I. INTRODUCTION

A. Need

Onion is the most important crop in India. The harvesting of onion crop is rigorous and requires huge amount of manpower and time. One of the main reasons of low productivity is insufficient power availability on the farm and low level of farm mechanization. This is especially true for India. The package of modern technology, improved seed and fertilizers, use of efficient and economical farm implements, machines and suitable form of farm power is very important. Production suffers because of improper seed bed preparation, delay in sowing and harvesting. Mechanization enables the conservation of input through precision metering, ensuring better distribution, reducing quantity needed for better response and prevention of losses or wastage of inputs applied. Mechanization reduces unit cost of production through higher productivity.

Harvesting depends on its type and purpose such as greens, immature bulb & mature bulb. Optimum time of harvesting is one week after 50% of leaves have fallen. Maturities symptoms include yellowing of leave and dry at the top; bulbs turn red and attain their optimum varietal size. Bulbs continue to grow even after the foliage has fallen down.

Generally the harvester is attached at the back end of tractor from where power is supplied to it through PTO(Power Take-Off) shaft. Also when attached at the back of the tractor it acts a pull type of mechanism rather than push type mechanism which consumes considerably more power.

A general design of onion harvester consist of following basic systems

1. Digging system.
2. Soil separation system.
3. Conveyor system.
4. Windrowing System/Collection unit.
5. Power transmission.

1.1 Digging System

The Digging system digs out the onion bulb from the soil. The depth of digging varies according to the planting method used and size of onion at the time of harvesting.

In case of continuous planting method the depth of digging is kept up to 10cm as the bulb is at adept of 5cm.

Fig.1 Image showing continuous type of planting

In case of bed type of planting method the depth of digging is kept upto 5cm as the bulb is comparatively near to the surface.

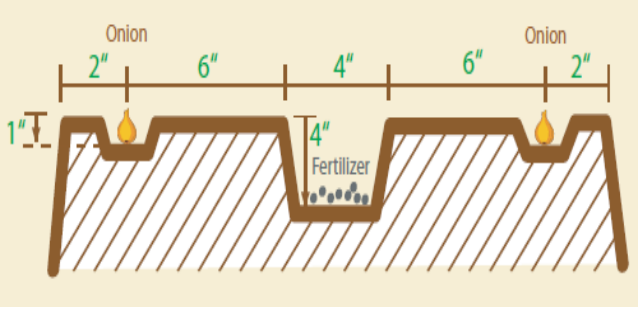

Fig.2. Diagram showing bed type of planting method

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The Harvesters currently available in the market have flat triangular type blades made of metal sheet. Care should be taken while designing blades as its sharp corners my damage
the onion bulb.

1.2 Soil Separation System

Once the onion is digged out of the soil, some soil comes
along with the incoming onion which needs to be cleaned. The
soil is dry as the water is cutoff nearly a week ago before the
time of harvesting. Due to this no aggressive cleaning of onion
is required.

Fig.3. Image of harvested onion bulb

As shown in Fig.3. the onion bulb is free from soil. So many
harvestors are simply provided with a conveyor to remove the
soil.

1.3 Conveyor System

Fig.4. Image of conveyor system[3]

The onion after soil removal is passed to a conveyor which
moves it to the collection unit. The conveyor can be belt type
Chain type according to the load of the material to be handled.

1.4 Windrowing/Collecting Unit

Fig.5. Windrowing system[3]

The onion after the conveyor goes to the windrowing system where it is made to fall in a straight line on the ground, so that it helps in collection of the onion. Sometimes a collection tray or basket is provided to collect harvested onion.

1.5. Power Transmission

The power it given to the rear conveyor from the PTO shaft. From PTO shaft proper gearing is provided to transmit power to the conveyor. A suitable belt or chain drive be given for transmitting the power to the conveyor shaft.

2.1 PROBLEM STATEMENT

In India the average farm size of farmers is less than 3 hectors, hence the large scale machine developed by various agricultural equipment manufacturing firms are not suitable for the Indian market. And also the average monthly income of Indian farmers is Rs 6426, so the machine also needs to be cost effective. Also it should be easily coupled to a small tractor of 15 to 20 HP.

So in simple words the challenge is to design a compact, cheap yet effective onion harvester suitable for Indian farm conditions.

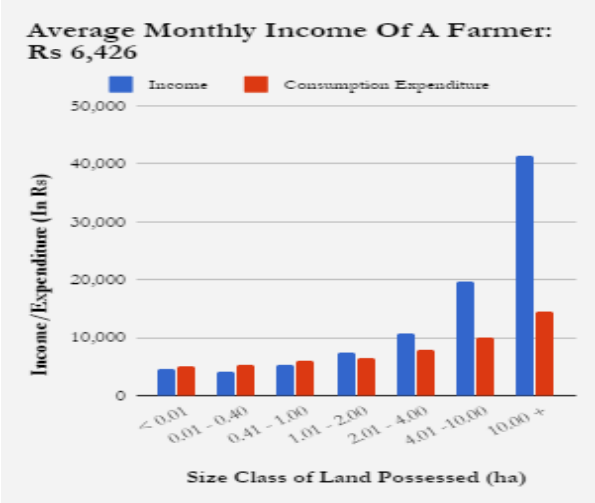

Fig.6. Bar charts showing income of farmers

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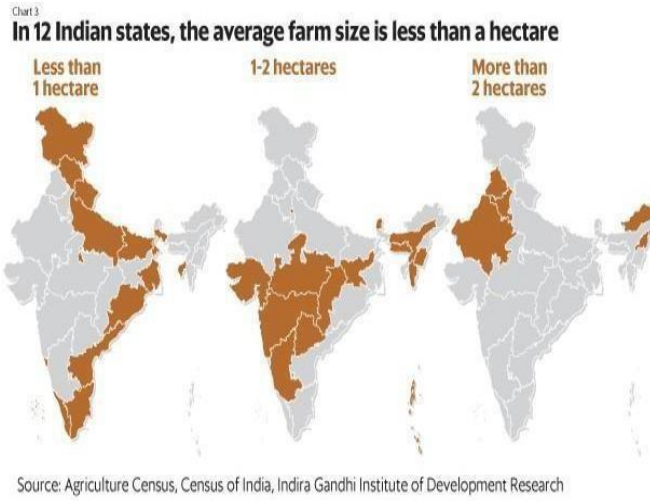


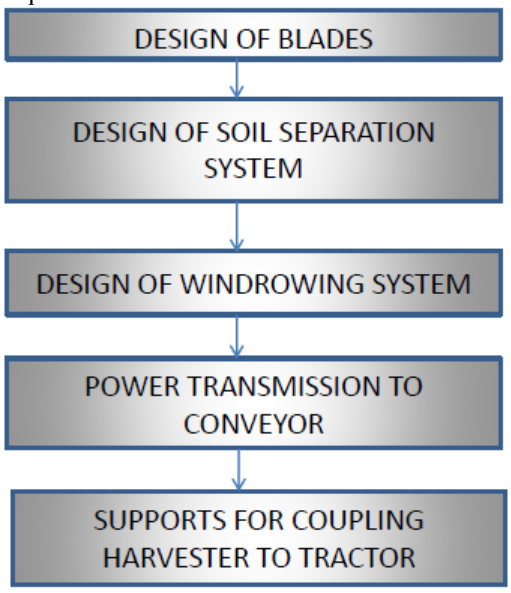
Fig.7. Average farm size in various states of India

2.2 OBJECTIVES

1. To design a new onion harvester to suit the need of farmers in India.
   - To design new blades to reduce soil resistance.
   - To design an effective soil separation system.
   - To design a system to collect the harvested onion.
2. To manufacture a cost effective onion harvester.
   - To use cost effective manufacturing methods to manufacturing various components.
   - Selecting cost effective materials.

2.3. METHODOLOGY

The onion harvester available in the market have some drawbacks which can be overcome by providing some design modification to the various systems of an onion harvester. The modification are provided by keeping into consideration the requirements of Indian farmers



2.4 Analysis

Ansys of Blade

a. **Selection of geometry**-Blade geometry was selected
Material- EN8

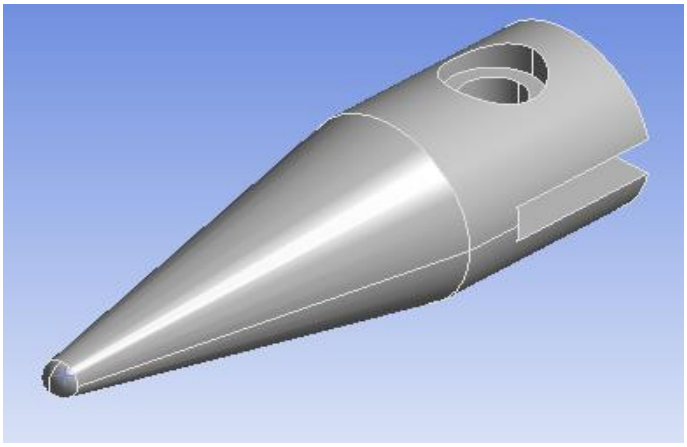


Fig.8. Blade geometry

b. **Meshing of blade geometry**

Element type-Triangular shaped
Element Size-4mm

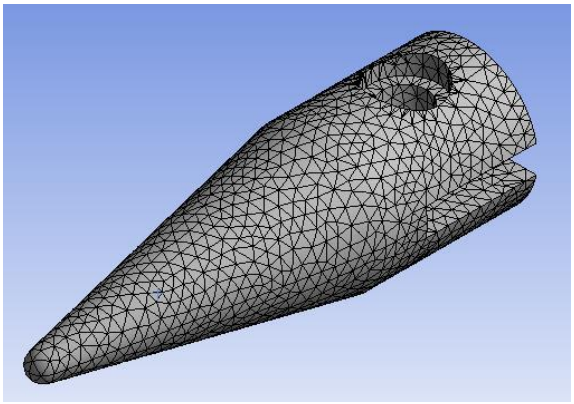


Fig.9. Meshing of blade geometry

c. **Applying boundary conditions**
Fixed support

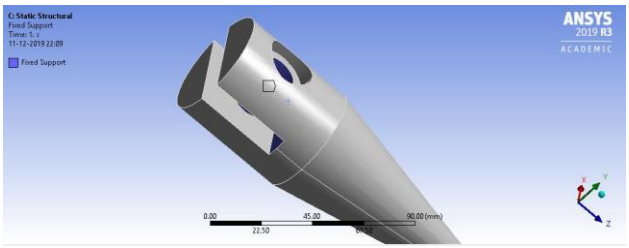


Fig.10. Support generation

d. **Force applied**

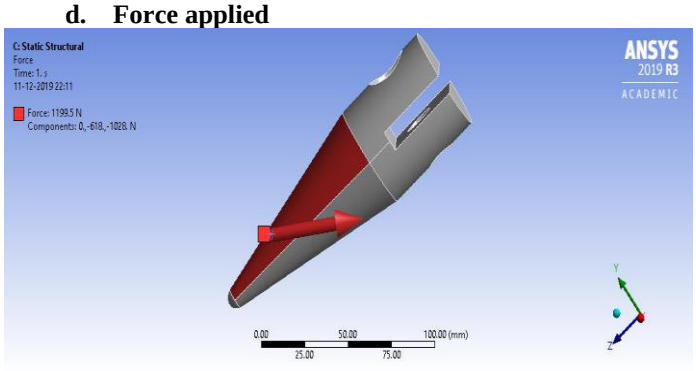


Fig.11. Force Application

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e. Results

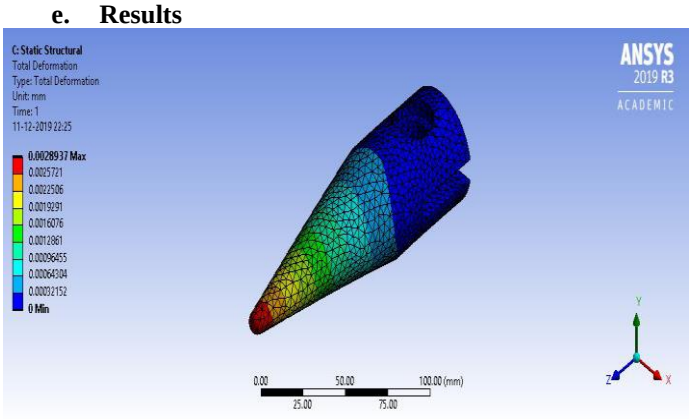


Fig 12. Total deformation

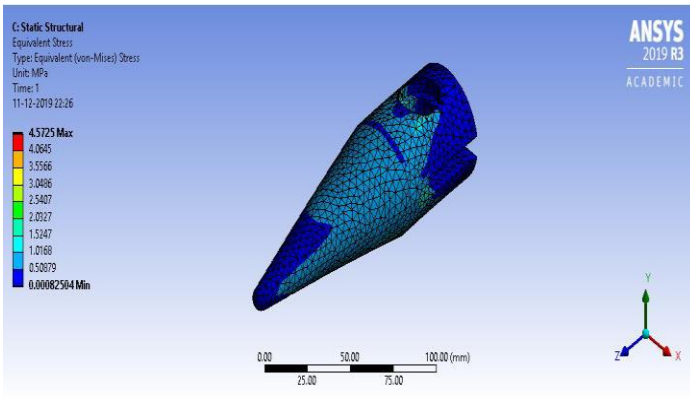


Fig. 13. Maximum stress

mesh sizing					
sr no	element s	nodes	elements	total deformation	equivalent stress
1	default	5202	2696	0.0028627	4.2737
2	5	18348	11763	0.0028866	4.0021
3	4	33970	22514	0.0028937	4.5725
4	3	76333	52400	0.0028996	4.4663
5	2	248533	175820	0.0029078	5.2748

2.4 Design Calculations

2.4.1 Digging Force:-

1. Cutting Blade shape: Conical
2. Blade Material: EN8
3. Rake Angle: 20^0
4. Throat Clearance Calculation: 90 mm

Digging force is calculated by

$$P = 0.0082\{(V2yw)\left(\frac{C + Ca}{V2y}\right) * 0.84\left(\frac{d}{w}\right) * 1.4(sin\alpha)\}$$

(1)

Where,
V= Velocity of tractor/blade, (mm)
y= Soil bulk density, (KN/m^3)
w= Tool width, (m)
α = Rake angle, (degree)
d= Tool depth, (m)
C= Cohesion (kPa)
Ca= Adhesion (kPa)

Draft Calculations

$$P = (y * Z_1 * 2N_y) + (C * Z_1 * N_c)$$

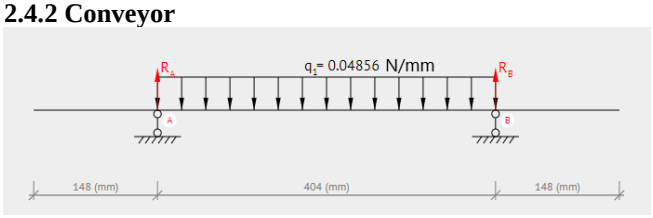
(2)

For black cotton soil,
N_y = 1.55 for δ =0 = Angle of shearing resistance of soil
N_y = 1.75 for δ =φ δ = Angle of metal friction
N_c = 1.65 for δ =0
N_c = 1.6 for δ = ϕ
y= 17.68 kN/m^3
C= 30.18 kN/m^2
Z_1= Depth of operation = 10cm = 0.1m

$$P = (17.68 \times 10^3 \times 0.1 \times 2 \times 1.75) + (30.18 \times 10^3 \times 0.1 \times 1.65)$$

P= 5289.1 N For Black soil

2.4.2 Conveyor

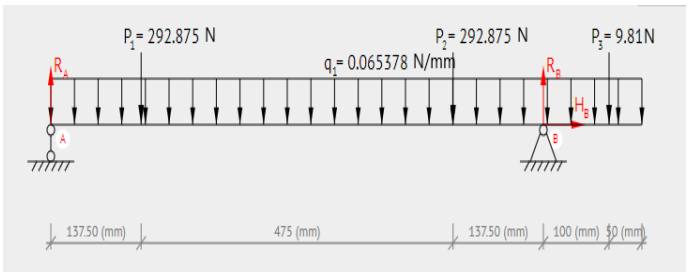


Diameter =12.595 mm

Weight of sprocket =9.81 N, $v = \frac{\pi * d * n}{60}$ (3)

$$n = \frac{60 * 2}{\pi * 0.115}$$
$$n = 332.14\ rpm$$
$$v = 2\ m/s$$
$$D = 115\ mm$$
$$P = \frac{2\pi nT}{60}$$
$$P = 0.472\ KW$$

BM_{max} = 0.9908 Nm =990.8 N.mm
thickness =1.7025 mm
C = $\frac{diameter}{16}$ = 0.787
M_b =44.0489 Nm = 44048.9 N.mm
M_t =271520 N.mm
I_{max} =59.4 N.mm
d=28.83 mm



d=28.83 mm

CONCLUSION

After studying the various harvester and testing the newly added design modifications following conclusion were drawn.

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- The conical blades would reduce the chance of onion damage.
- Simple manufacturing methods involved in the manufacturing of harvester components would reduce the cost considerably.
- Standard manufacturing components and methods used would help in interchangeability.
- It would increase productivity, which lead to increase in profit for the farmers.

FUTURE SCOPE

The design can evolve further by giving additional attachments to it. The following design inputs can be added if required

- A attachment can be provided for cutting the onion leaf at the time of harvesting.
- Collecting baskets can be provided for collecting the harvested onion.
- In case the soil is stuck to the onion bulb and is not coming off easily in this case a vibrating conveyor mechanism can be provided.
- With some small changes same mechanism can also be used of potato harvesting.

REFERENCES

[1] Design of onion harvester – ashwini talokar, kanchan wankhade, & v. P. Khambalkar, published by international journal & magazine of engineering, technology, management and research.
[2] Design and Fabrication of Underground Vegetable Harvester S.S.Parthipan, Raj parthipans, Department of Mechanical Engineering, Easwari College Of Engineering, Chennai, published by International Journal of Mechanical Civil and Control Engineering.
[3] Design of onion harvester, published by www.yuvaengineers.com
[4] Survey of Indian agricultural economy, Published by World Economic Forum.
[5] Survey of farm sizes in various states, published by Ministry of Agriculture and Farmers Welfare, Government of India.
[6] Onion Varieties, Submitted by Vinod Kumar, published by agropedia.