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## Design, Development and Manufacturing of Drive Train for Self Propelled Onion Harvester

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**ABSTRACT:** India is well known for its agriculture which affect country economy most part and India is the second largest country who produces the onion crop. But even though it is on 2nd number still it is lagging because India is still developing country among the whole world and in whole over country around 80% to 90% harvesting is carried out by traditional method. Proposed event organised by SAE INDIA which focuses on optimizing the time required to harvest onion after the completion of crop. Our aim of the project mainly focuses on the time as well as the work efficiency. This may include the time and labour cost, thus indirectly it can be compared with machine efficiency against manual efforts required. By use of digger and conveyer system the harvesting has been done. This is beneficial for more productivity of the crop. The traditional and most widely used method of harvesting onions involves undercutting and lifting onions when the foliage has collapsed to 60-70% of the plants. Onions are left on the ground to cure in the field for 1-4 weeks before the foliage is removed (topping). There is a lot of demand of Indian Onion in the world, the country has exported 14, 82,498.58 MT of fresh onion to the world, worth of Rs.3,169.63 crores, during the year 2018-19. The height of the onion crop during harvesting is 15-40 cm and the crop stem diameter is 1-2 cm. The number of shoots per plant is 10-15. During hot days when the soil is hard, bulbs are pulled out with a hand-hoe. The production of onion is 12-16 tonnes in 70 to 90 days. Manual harvesting of onions is a tedious, time consuming, labour intensive and costly operation so mechanization of harvesting is essentially needed. Mechanization of onion harvesting needs as traditionally, the well-matured bulbs are harvested by hand shovel (khurpa) which requires 21.4 per cent of total expenditure of onion cultivation. About 12.5-man hours are required in manual de-topping operation of 1 MT onion bulbs. Hence, mechanical de-topping is required. Also, it is necessary to complete the harvesting operation within specified time limits, for reducing harvest losses and increasing storage life. In fact, early harvesting affects the keeping quality of onions adversely and reduces the yield, whereas delayed harvesting leads to infection caused by microorganisms. Harvesting of onion is more labour intensive and bulb damage is higher during harvesting. For the same, the optimization is to be done several times to make a robust and rigid design in order to withstand drag, tractive and torsional forces against the digging effort of the vehicle. This process includes designing as well as simulation process that will give us 99% accurate result and after a various test and analysis, we came to a conclusive result that it will work in real time as Onion harvesting machine.

**KEYWORDS:** Harvesting, Topping, Mechanization, Optimizing

### I. INTRODUCTION

India is the second largest onion growing country in the world. Indian onions are famous for their pungency and are available round the year. Indian onions have two crop cycles, first harvesting starts in November to January and the second harvesting from January to May. The onion is a hardy cool-season biennial but usually grown as annual crop. The onion has narrow, hollow leaves and a base which enlarges to form a bulb. The bulb can be white, yellow, or red and require 80 to 150 days to reach harvest. The major Onion producing states are Maharashtra, Madhya Pradesh,

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Karnataka, Gujarat, Rajasthan, Bihar, Andhra Pradesh, Haryana, West Bengal, Uttar Pradesh, Chhattisgarh, Odisha, Tamil Nadu, Jharkhand and Telangana in the country. Onion can be grown in all types of soils such as sandy loam, clay loam, silt loam and heavy soils. However, the best soil for successful onion cultivation is deep, friable loam and alluvial soils with good drainage, moisture holding capacity and enough organic matter. In heavy soils, the bulbs produced may be deformed. Onion crop can be grown successfully on heavy soil with application of organic manure prior to planting and preparation of the field for onion cultivation should be very good. The optimum pH range, regardless of soil type, is 6.0 - 7.5, but onion can also be grown in mild alkaline soils. Onion crop is more sensitive to highly acidic, alkali and saline soils and water logging condition. Onions do not thrive in soils having pH below 6.0 because of trace element deficiencies, or occasionally, Al or Mn toxicity. By keeping all those points in consideration, the onion harvesting machine is been developed. Onion is harvested depending upon the purpose for which the crop is planted. Onion crop is ready for harvesting in five months for dry onion. The process of onion harvesting with help of the harvester starts from losing the soil up to removal of onion with green leaves above the ground. In manual process, most of the onion are removal with damaging the any part of the onion. But this process is time consuming. In order to achieve the time as well as the clean removal of the onion this machine is develop.

## II. LITERATURE REVIEW

**Attri et al. (2015)[1]:** Have explained significant variant amongst the 47 onion crops. Also, it includes the leaf length, leaf height, leaves per plant, polar equatorial radius of the onion bulb, average bulb weight, total soluble solids.

**Promod Reddy et al, 2017 [2]:** Have explained theoretical aspects of potato harvesting machine. In this, all efforts taken by human being that has to be reduce are considered and aspect as has been kept in front to maximize the quality of the product harvested within required time and low cost.

**Sunil Shirwal et al, 2015 [3]:** Have explained the carrot harvester was evaluated for different levels of rake angle, soil separator length and angle of soil separator. The efficiency of removal of developed crop has also explained. The developed carrot harvester can harvest the crop 49% cost and 96% time saving, as compared to traditional.

**Sungha Hong et al, 2014 [4]:** Have explained, mechanism of harvesting welsh onion, a process that has traditionally depend on labour, will increase productivity and efficiency through the development and use harvester which has been tested for the performance on newly developed onion in welsh onion cultivation farm.

**Bendix et al. (2001)[5]:** studied that mechanical harvester for harvesting, topping and Sacking bulb crops, Such as onions. The harvester extracts the onions from the ground and transports them rearward to a cutting assembly by conveyor Systems that drop out Small onions, dirt, rock sand debris. The cutting assembly comprises a Set of elongated cutting blades positioned to co-operatively accept and sever the leaves and roots from the bulb.

**Gavinoet al.(2018)[6]:** study yielded that an onion harvester attached to the locally available hand tractor was designed and fabricated to harvest onions with a field capacity of 0.086 ha per hour and a field efficiency of 80.52%. With this machine, the required labour for harvesting onions was reduced from 122 to 69 man-hours per ha. The computed custom rate of digging and windrowing onions per hectare using the machine is PhP1,850, resulting to a decrease of about P3,300 per ha for the complete harvesting operations

**Mozaffaryet al.(2019)[7]:** studied the required mechanism and rotary speed of blade for cutting for removal of onion bulb top. The approximate speed which is suitable for it was from 1500 – 2000. Tests done in two stages. Some parameters such as acceptable top percentage, not acceptable top percentage, not topped percentage and damaged bulbs percentage were determined and analysed. The

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results showed that flail topper was the most suitable mechanism for onion topping. It could give following result: 87.7% acceptable top at 2000 rpm in stage one and 83.9% acceptable top at 1500rpm in second stage.

### OBJECTIVE OF PROPOSED WORK:

- Our main objective is to optimize Drive train of the onion harvester.
- To develop and evaluation of self propelled onion harvesting machine.
- To reduce the speed of gear box from 3000 rpm to 36 rpm i.e. Up to 6 km/hr

### ENGINE SPECIFICATION :

- Make/Model : Kirloskar Oil Engines Ltd. (KOEL)/ CC418
- Type : Single Cylinder, Diesel, 418CC, Vertical,
- Rating : 8 hp@3000rpm
- Max Torque : 19N.m@2000rpm
- High Idle : 3300rpm
- Dry weight : 44kg
- Size : 470x310x490cm
- Fuel tank capacity : 3.5L
- Starting method : Rope Start
- Decompression lever
- Each engine will come following scope of supply
- Base Engine with wire start aid
- Air Cleaner
- Exhaust muffler
- Integrated Fuel tank (3.5 Lit.) Engine Speed = 3000 rpm

### Calculations-

#### PERFORMANCE CHARACTERISTICS CALCULATIONS: (THEORETICAL)

**Rolling Resistance** =  $R_r = KW$

Where,

W = Weight of vehicle = 570 kg

K = constant of rolling resistance = 0.0435 (for loose sand roads)

$R_r = 570 \times 9.81 \times 0.0435$

Rolling Resistance (**R<sub>r</sub>**) = **243.23N**

#### **Air Resistance**

**Air Resistance** =  $0.5 * C_d \rho v^2 A$

Where,

$C_d$  = Coefficient of Drag

$\rho$  = Density of air

V = Velocity

A = Area

**Air Resistance** = **2.279N**

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### Tractive Effort while digging-

Tractive effort While digging= RD+ RR+ Digging resistance

$$= 8670.319 \text{ N}$$

### Traction-

$$T_w = (E_n/W_n).ht.TE$$

$$= 2500650.8518.5$$

$$= 604.80 \text{ N.}$$

### Tractive effort on road-

$$F = T_w/r$$

$$= 1478.72 \text{ N}$$

### Accleration-

$$a = (1/w) * (F - R)$$

$$= 2.16 \text{ m/s}^2$$

### Drawbar pull-

$$\text{Drawbar Pull} = \text{Drag force} * \cos(\text{rake angle})$$

$$= 1546.29 \text{ N}$$

$$= 157.62 \text{ kg}$$

**(Table 1)Reduction Gear Box-**

Stages	Ratio	RPM	Torque(N-m)
1	1:1	2500	18.5
2	2:1	1250	37
3	3:1	416.66	111
4	3:1	138.88	333
5	1:1.5	208.32	222

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(Table 2) Main Gear box

Gear	Ratio	RPM	Torque(N-m)	Speed(km/hr)
1	26.43	7.88	4987.34	1.21
2	13.42	15.52	2532.35	2.39
3	7.19	28.97	1356.75	4.46
4	5.81	36	1096.34	5.52
Reverse	21.24	9.80	4007.98	1.51

### III. RESULT

Table 3

Reduction Drives	Reduction Ratio
Bevel Gear Box	1:1
Reduction Gear Box	12:1
Timing Belt Drive	1:1.5

Table 4

Performance Characteristics (For Top Gear) (On Road)	
Torque at Wheel	604.80 N-m
Tractive effort	1478.73 N
Gradability	49.39 %
Acceleration	2.16 m/s <sup>2</sup>
Drawbar pull	157.62 kg
Travel speed	6 km/hr

### IV. CONCLUSION

This process includes designing as well as simulation process that will give us 99% accurate result and after a various test and analysis, we came to a conclusive result that it will work in real time as Onion harvesting machine. Drive train

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of the onion harvester is optimised. Reduction of the speed of gear box from 3000 rpm to 36 rpm i.e. Up to 6 km/hr is achieved.

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