



ISSN (E): 2277- 7695  
ISSN (P): 2349-8242  
NAAS Rating: 5.23  
TPI 2021; SP-10(11): 2830-2833  
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[www.thepharmajournal.com](http://www.thepharmajournal.com)  
Received: 01-09-2021  
Accepted: 03-10-2021

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## Groundnut harvester: A concept

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#### Abstract

Harvesting of groundnut is one of the most important operations in groundnut cultivation. During peak seasons due to the non-availability of labour, delay in harvesting of groundnut and results in heavy losses. For minimizing the labour problems during peak harvesting seasons and to ensure timeliness operation an attempt was made to develop a conceptual model of groundnut harvester that will be able to uproot, pick and convey the plant and strip the pods from the plant while moving through the field. To carry out the desired function, the groundnut harvester comprise of a digging unit, conveying unit, pod stripping unit and collection unit. The digging unit penetrates into the soil up to the desired depth and brings out the groundnut plants with pods on the ground surface. Conveying unit will pick up the plant and convey it to pod stripping mechanism which stripped the pods from the plant due to its impact force and will allow them to fall into the collection unit. The stripped pods and plants will be collected in separate collection unit.

**Keywords:** groundnut harvester, digging unit, conveying unit, pod stripping unit

#### Introduction

India is one of the major producers of oilseeds in the globe and occupies an important position in the Indian agricultural economy. It is one of the most important oil and cash crops in our country. It is generally grown for production of edible oil, protein and carbohydrates (Abdazad and Noorhosseini, 2010) [1]. It is not only important source of all the nutrients but also a low priced commodity. The seed of groundnut contains 22 to 30 per cent protein and 44 to 56 per cent oil on a dry seed basis. It is rich in minerals (P, Ca, Mg and K) and Vitamins (E, K and B group) (Savage and Keenan, 1994) [13]. Harvesting is one of the most important operations in groundnut cultivation. Harvesting of groundnut is done when most of the leaves turned into yellow colour and pods became mature and hard (Arakama, 2009) [3].

Harvesting of groundnut crop is one of the most essential and labour intensive operation. Groundnut produces its fruit below the soil thus in order to bring pod on ground surface, digging operation is required. Generally, the groundnut pods (fruits) are located between 7 to 10 cm below ground surface and this zone is commonly known as the pod zone (Ademiluyi *et al.*, 2011) [2]. In most parts of the country, harvesting of groundnut is generally done in the traditional way, in which crops are uprooted from the soil with the help of labour and tied them into a bunch, allow them to dry so that pods can be easily stripped from plant. The stripping of the pods from plants is also done manually. Manual harvesting and threshing of groundnut required 84 man h/ha. Shortage of labour during harvesting is another problem. The traditional method of harvesting groundnut normally consumes much time and labour. The non-availability of labour during peak period results in delayed harvesting which turn into heavy loss to the farmer (Padmanathan *et al.*, 2006) [8].

Another type of harvesting is done by mechanical means with the help of blade type harvester and digger shaker. The field capacity of blade type harvester is about 3 to 5 ha/day depending on field condition. The groundnut digger cum shaker performs three operations simultaneously. It digs into the soil uproots the groundnut crop and removes the soil from pods by shaking of plants and then windrowing the crop in the rows. The capacity of digger cum shaker is around 0.6 to 0.8 ha/hr depending upon the operating condition. However, both implement only uproot the crop and pods are to be stripped manually. The traditional method of harvesting of groundnut is most labour and time consuming also it involves lots of drudgeries as the worker has to uproot the plants in bending posture. The available mechanical harvester such as blade type and digger cum shaker only uproots the crop. Thus, save time/labour only in uprooting operation. However, labor requirement for rest of operation such as the collection of the crop, tying them and stripping of the pod is the same as in traditional method.

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Complete mechanization of groundnut harvesting operation is one of the solutions so that it minimizes the harvesting cost and improves productivity and profitability. It is possible by developing groundnut harvester which performs uprooting of plant, conveying of plant, stripping of pods, collection of pods and plant leaves simultaneously in separate collection unit. The collected green plants/leaves are rich in nutrient can be used as fodder for an animal.

### Material and Methods

The main objective of the study was to develop harvester which can loosen the soil around groundnuts plant/pod, lift the groundnut plants to a certain height by holding leaves and convey the plant along with groundnut pods to the pod stripping unit for separating pods from plant. Finally the groundnut pods and leaves will be collected separately into the storage bin.

Factors influencing the design of groundnut harvester are as follows.

#### 1. Machine parameter

a) Source of power b) Operating speed c) Output capacity d) Centre of gravity e) Digging mechanism f) Conveying mechanism g) Pod stripping mechanism h) Storage

#### 2. Soil parameters

a) Type of soil b) Bulk density c) Soil moisture content

#### 3. Crop parameter

a) Cropping pattern b) Maturity c) Variety d) Plant population e) Row to row spacing f) Shoot length g) Pod depth

### Design consideration of groundnut harvester

1. The digging blade should uproot the plant and able to loosen the soil around the pods without damaging the pods.
2. The chain conveyor should be able to pick the plant at a specific height and convey the picked plant with the pod at a uniform space to the pod stripping drum.
3. The pod stripping drum/unit should strip the pod from the leaves due to its impact force.
4. The pod should be collected into the collection unit.
5. The remaining leaves should be conveyed by conveying chain and dropped in the field in a uniform manner or collected in bags for fodder purpose.
6. Power, labour requirement should be minimum and economically feasible.
7. The Harvester should be simple, easy to fabricate, easy to operate and transport.

### The groundnut harvester comprise of the following unit

- i. Digging unit- To dig the soil and uproots the crop.
- ii. Conveying unit- To convey the uprooted crop to the pod stripping unit
- iii. Pod stripping unit- To strip the pods from the plant
- iv. Collection unit- To collect stripped pods.

#### Digging unit

The sweep type blade will be selected for digging of the crop (Sihag *et al.*, 2018) <sup>[6]</sup> and chisel point will be provided for ease of penetration in the soil (Awadhwal *et al.*, 1995) <sup>[4]</sup>.

#### Width of the digging blade

Effective zone of sweep type blade is determined by

following formula

$$Z_f = W + 2d \tan \phi_s \text{ (Sharma and Mukesh, 2013) }^{[12]}$$

Where,

$Z_f$  = Effective zone of blade, cm

$W$  = Blade width, cm

$d$  = Operating depth, cm

$\phi_s$  = Angle of internal friction (10 to 30°)

Apex angle ( $2\theta$ ) - The angle formed between the two cutting edges of blade is known as apex angle.

$\theta = 90^\circ - \phi_w$

Where,

$\phi_w$  = Angle of friction between soil and cutting edge (30 to 56°) (Sharma and Mukesh, 2013) <sup>[12]</sup>

### Conveying unit

Chain type conveying mechanism will be selected for the harvester. The conveyor angle will be kept adjustable, ranging from 25° to 45° for mating crop requirement and ease of transportation. The linear speed of conveyor chain is to be decided on the basis of the forward speed of the operation. In order to avoid the clogging of a plant at the picking point, the linear speed of a chain should be equal to or slightly more than the forward speed of the tractor (Not more than 110 %, Kirk *et al.*, 2017) <sup>[5]</sup>. The conveying unit is shown in Figure 1.

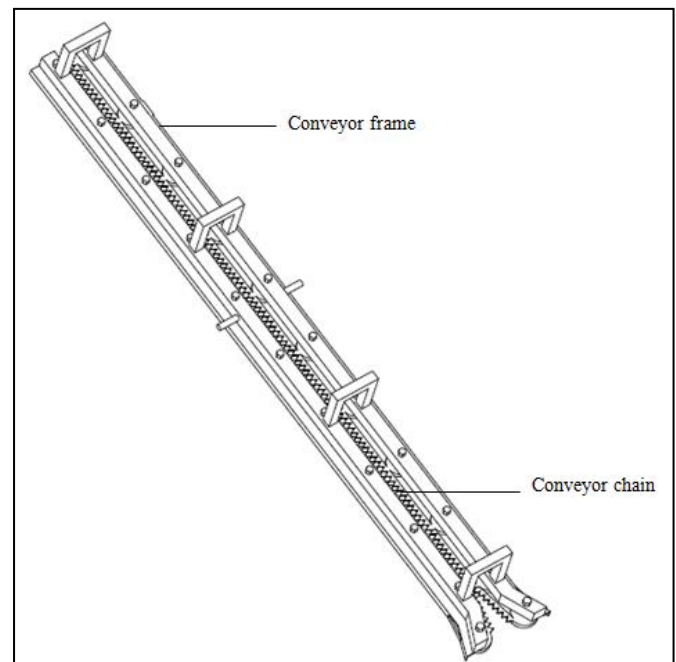


Fig 1: Conveying unit

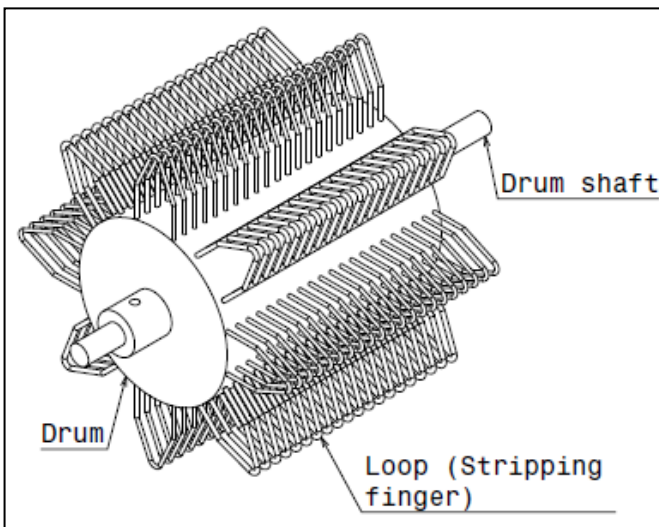
### Pod stripping unit

Pod stripping unit consist of revolving drum having the loop type stripping finger welded over the periphery of the drum. The spacing between fingers on the periphery of the revolving drum will be kept less than the minimum mature pod dimension so that no pods were passed through fingers. The drum consists of eight rows of stripping finger welded on the periphery of the drum at an angle of 45° with the drum shaft axis. Stripping fingers in row will be welded in such a way that fingers from a row place exactly in between two fingers of adjacent row. The height of finger will be kept 100 mm depending on pod zone of groundnut plants. The stripping drum located at rear end of machine and below the chain

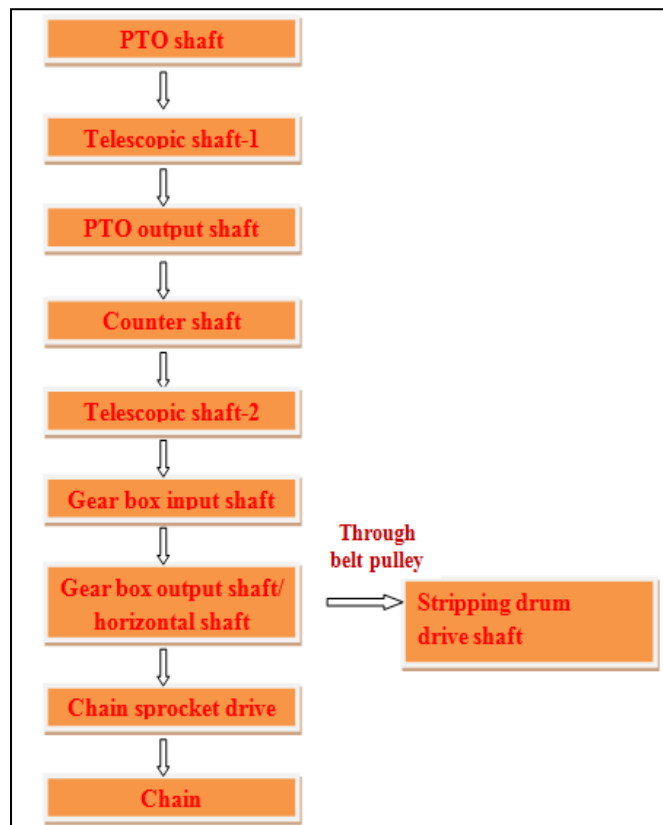
conveyor in such a way that clearance between tip of the stripping drum finger and conveyor chain will be 5 to 10 mm. The pod stripping drum is shown in Figure 2.

**Power transmission system**

The power transmission unit will be provided to give accurate motion to conveying and pod stripping unit. Power transmission system receives power from the tractor PTO and through the combination of chain sprocket, shaft, gears and belt pulley drive, it transmitted to all the working parts of the harvester. The flow path of power from tractor to pod separating drum is shown in Figure 3.

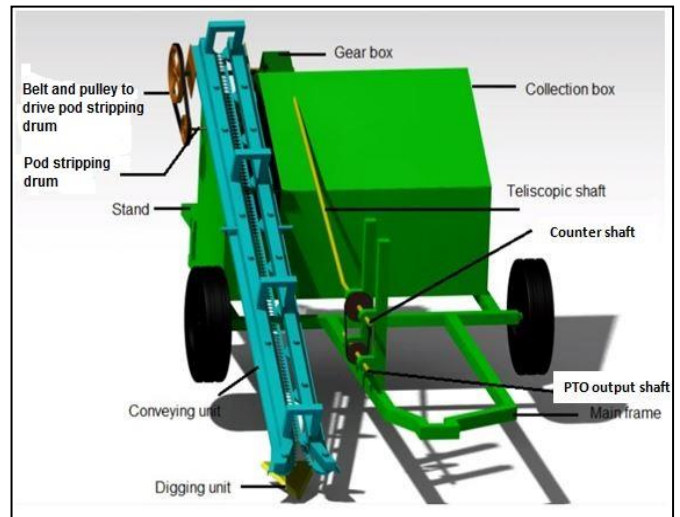


**Fig 2:** Pod stripping drum



**Fig 3:** Power transmission system

The conceptual design of the groundnut harvester is shown in Figure 4.



**Fig 4:** Conceptual Groundnut harvester

**Result and Discussion**

The conceptual groundnut harvester will performs digging, conveying, pod separation and collection of pod and plant simultaneously. Thus, it will save the time and labour cost in the harvesting of groundnut. The conceptual design of groundnut harvester proved to be effective. To test the productivity of machine in the groundnut harvesting it should continue with the next phases of design i.e. preliminary design, detail design, prototype model, testing and performance evaluation.

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