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Open Access Journal of Agricultural Research
ISSN: 2474-8846

Groundnut Digger cum Inverter: A Concept

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Mini Review
Volume 9 Issue 4
Received Date: October 14, 2024
Published Date: November 27, 2024
DOI: 10.23880/oajar-16000376

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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 digger that will be able to uproot, pick and convey the plant and invert the plant of groundnut while moving through the field. To carry out the desired function, the groundnut digger comprise of a digging unit and conveying 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 inverting mechanism which invert the plant and reduce the effect of aflatoxin in pods due to the saturated moisture.

Keywords: Groundnut Digger; Digging Unit; Conveying Unit; Inverting Mechanism

Introduction

Groundnut (*Arachis hypogaea*), a key oilseed and cash crop, is cultivated primarily for its high content of edible oil, proteins, and carbohydrates Lakhani AL, et al. [1]. It serves as a significant source of essential nutrients and remains an economically accessible commodity. Groundnut seeds contain 22-30% protein and 44-56% oil on a dry weight basis, making them a rich source of macronutrients. Additionally, they are abundant in minerals such as phosphorus (P), calcium (Ca), magnesium (Mg), and potassium (K), along with vitamins E, K, and various B-complex vitamins. Groundnut harvesting is typically performed when a majority of the plant's leaves turn yellow, and the pods reach full maturity, becoming firm and hardened. Groundnut develops its fruit below the soil surface, necessitating excavation for pod retrieval. Typically the groundnut pods are situated at a depth of 7 to 10 cm beneath the soil, in a region referred to as the "pod zone" Lakhani AL, et al. [2]. This zone requires precise mechanical or manual digging operations to bring the pods to the surface for harvesting.

In many regions, groundnut harvesting is predominantly carried out using traditional methods, where the plants are

manually uprooted using labor, then bundled and left to dry to facilitate the manual stripping of pods from the plants. This manual process, including harvesting and threshing, typically requires 84 man-hours per hectare. A significant issue associated with this method is labor scarcity during the harvesting period, which can lead to delays. These delays, caused by the non-availability of labor at peak harvest times, can result in substantial yield losses for farmers Padmanathan, et al. [3].

Mechanical harvesting of groundnut involves the use of equipment such as blade-type harvesters and digger-shakers. The digger-shaker performs three operations simultaneously: it penetrates the soil to uproot the groundnut crop, shakes the plants to remove soil from the pods, and arranges the uprooted plants into windrows. The operational capacity of the digger-shaker ranges between 0.6 and 0.8 hectares per hour, depending on field conditions.

While traditional groundnut harvesting methods are labor-intensive, time-consuming, and physically demanding—requiring workers to uproot plants in a bent posture—the blade-type and digger-shaker harvesters reduce labor and time by mechanizing the uprooting process. However, manual labor is still required for subsequent operations, such as collecting the plants and inverting them for drying. The inverting process is critical in preventing aflatoxin contamination in the pods after digging.

To optimize groundnut harvesting, complete mechanization is proposed as a solution. This would involve the development of a groundnut harvester capable of not only uprooting the plants but also conveying and inverting them efficiently, thereby reducing labor costs and improving both productivity and profitability. Factors influencing the design of groundnut harvester are as follows.

Methodology

Experimental site

The present study was conducted at the Department of Farm Machinery and Power Engineering, College of Agricultural Engineering and Technology, Junagadh Agricultural University, situated in Junagadh district, Gujarat. The experimental site is geographically located at 21º49'92'' N latitude and 70º44'61'' E longitude, with an elevation of 102.27 meters above mean sea level. The soil texture in the Junagadh region is predominantly sandy loam, characterized by the relative proportions of sand, silt, and clay. For the purpose of this study, a field area of 500 m^2 was utilized, where two varieties of groundnut (GJG-32, GG - 20 and GJG-9) were sown during the kharif season (July to October), coinciding with the south-west monsoon.

The main objective of the study was to develop digger cum inverter 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 inversion plant. Finally the groundnut plant will be inverted on the field. Factors influencing the design of groundnut harvester are as follows.

Sr. No.	Types of parameter	Parameter
1	Soil parameter	(1) Soil type
		(2) Soil moisture content
		(3) Bulk density
		(4) Cone index of soil
2	Crop parameter	(1) Cropping pattern
		(2) Variety
		(3) Plant height
		(4) Plant canopy
		(5) Plant population
		(6) Row to row spacing
		(7) Pod zone depth
3	Machine parameter	(1) Travelling speed (2.5 – 4.0 km/h)
		(2) Conveying chain speed (1.0 – 2.5 m/s)
4	Field evaluation parameter	(1) Digging efficiency (%)
		(2) Percentage of damage (%)
		(3) field efficiency
		(4) Picking efficiency (%)
		(5) Conveying efficiency (%)
		(6) Inversion percentage (%)
		(7) Field capacity (ha/h)

Table 1: Different Parameters for the Groundnut Gigger cum Inverter.

Functional Requirement of Groundnut Digger cum Inverter

Following functional requirements were considered for developing a new machine.

- The design should be simple and easy to fabricate, utilizing locally available materials to facilitate manufacturing.
- All components should be easily assembled and disassembled to allow for inspection, maintenance, and repair.

- The implement should be compatible with tractors in the 15 to 25 horsepower range, which are commonly used on Indian farms.
- The machine should leave groundnut pods uncovered on the soil surface behind the tractor, allowing for faster drying compared to existing diggers and minimizing pod loss during the digging process.
- The machine should minimize damage to groundnut pods, including cuts, crushing, slicing, and bruising.
- The machine should dig the groundnuts in a manner that minimizes the amount of soil adhering to the pods.
- The depth of digging should be controlled by a hydraulic mechanism.
- Pod losses should be minimized by employing a V-shaped digging blade.
- The design should be simple, structurally robust, and capable of efficient performance.

The Groundnut Digger Cum Inverter Comprise of the Following Unit

Digging Unit: To dig the soil and uproots the groundnut plant.
Conveying Unit: To convey the uprooted plant to the plant inversion mechanism.
Inverting Mechanism: To invert the plant by inverted rod.

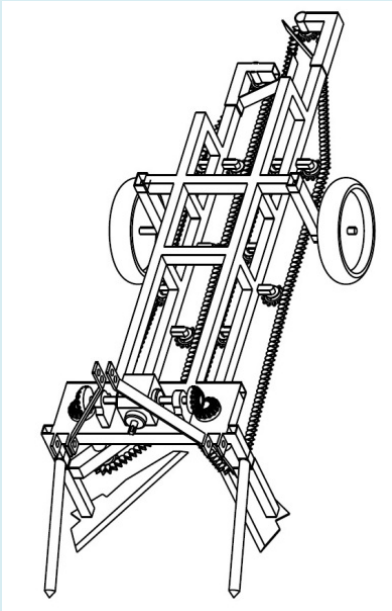

Figure 1: Conceptual Groundnut Digger cum Inverter.

Digging Unit

The V type blade will be selected for digging of the root crop for easy penetration and reducing draft Suryawanshi, et al. and Amin, et al. [4,5].

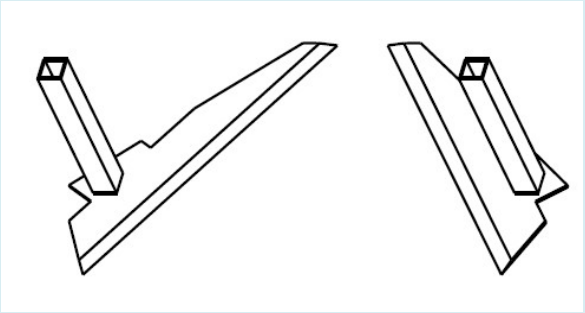

Figure 2: Isometric View of Digging Blade.

Width of the Digging Blade

Effective zone of sweep type blade is determined by following formula Sharma DN, et al. [6]

$$Z_f = W + 2d \tan \varnothing_s$$

Where,
Z_f = effective zone of blade, cm
W = width of blade, cm
D = operating depth, cm
Øs= angle of internal friction (10° to 30°)

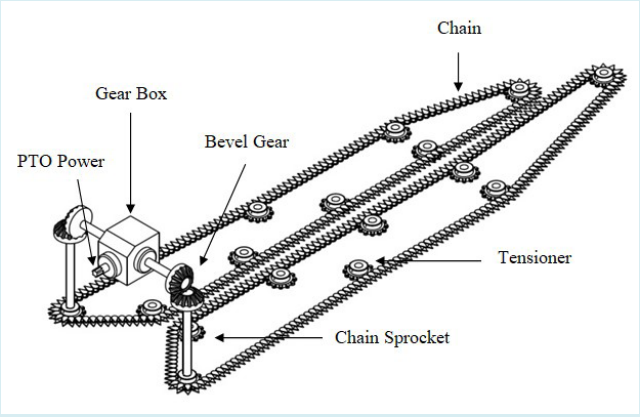

Figure 3: Power Transmission System.

Power transmission system

A chain-type conveying mechanism will be selected for the harvester. The conveyor angle will be adjustable, ranging from 25° to 45°, to accommodate varying crop requirements and ensure ease of transportation. The linear speed of the conveyor chain will be determined based on the forward operational speed of the harvester. To prevent clogging of plants at the picking point, the linear speed of the conveyor chain should match or slightly exceed the forward speed

of the tractor, but should not exceed 110% of the tractor's speed Lakhani, et al [7].

Result and Discussion

The conceptual groundnut digger is designed to perform digging, conveying, and inverting of the plants simultaneously, thereby reducing both time and labor costs associated with groundnut harvesting. Initial evaluations of the conceptual design have demonstrated its effectiveness. To further assess the machine's productivity in groundnut harvesting, it must advance through the subsequent phases of design, including preliminary design, detailed design, prototype development, testing, and performance evaluation.

References

1. Lakhani AL, VR Vagadia (2023) Development and performance evaluation of shelling unit of power operated groundnut decorticator. International Journal of Agricultural Sciences 19(1): 254-260.

2. Lakhani AL, Faldu, Dhruvkumar J, Verma K, Khanpara BK, et al. (2024) Investigation on soil and groundnut plant characteristics for the design and development of groundnut digger cum inverter. Plant Archives 24(2): 415-421.

3. Padmanathan PK, Kathirvel K, Manian R, Duraisamy VM (2006) Design, development and evaluation of tractor operated groundnut combine harvester. Journal of Applied Sciences Research 2(12): 1338-1341.

4. Suryawanshi SH, Kathirvel K, Shridar B (2009) Comparative Evaluation of Different Groundnut Digging Blades. Agricultural Mechanical in Asia, Africa and Latin America 40(1): 9-11.

5. Amin EA, Ismail ZE, Elshabrawy TH, Faleih HS (2014) Influence of some factors affecting carrot harvesting. Journal of Soil Sciences and Agricultural Engineering 5(6): 911-912.

6. Sharma DN, Mukesh S (2013) Fram Machinery Design, Principles and Problems. In: 3rd (Edn.), Jain Brothers, New Delhi, India.

7. Lakhani AL, Gaadhe SK, Kathiria RK, Mehta TD (2024) Mini tractor operated groundnut digger cum inverter: A concept. Ergonomics International Journl 8(4): 334.