*The Andhra Agric. J* 60(2):433-437, 2013

# Performance Evaluation of a Groundnut Digger Shaker cum Windrower

**K Madhusudhana Reddy,D Vijay Kumar, B Ravindranatha Reddy,**
**B Sahadeva Reddy and V Munaswamy**
Department of Agricultural Engineering, Agricultural Research Station, Anantapur

**ABSTRACT**

Mechanization of groundnut harvesting is very important field operation to increase pod recovery from the soil. Various methods followed for harvesting of groundnut is by hand pulling, animal and tractor drawn groundnut diggers. A commercially available tractor operated groundnut digger shaker cum windrower having the inverted V geometry soil cutting tool was tested during 2011-12 for its performance in the light red soil condition at Agricultural Research Station, Anantapur. The harvesting efficiency was 96% at the field capacity of 0.19 ha/h with the fuel consumption of 4.09 l $h^{-1}$. The conveying and soil separation efficiencies were 96% and 97.2% respectively with the conveyor loss of 0.6%. Draft observed was 4.95 kW at the operating speed of 4.4 km/h.

**Key words :** Digger shaker cum windrower, Groundnut, Manual harvesting, Mechanical harvesting.

Groundnut (*Arachis hypogea L*) is an important source of edible oil in India and cultivated in an area of 5.8 million ha with a productivity of 948 kg $ha^{-1}$ as against the world average productivity of 1400 kg $ha^{-1}$ (FAO, 2011). Groundnut is cultivated as a major oilseed crop in Andhra Pradesh and is the 3rd largest state with production about 1.6 million tons annually grown in an area of 1.7 million ha. The productivity of groundnut can be increased by the introduction of improved varieties and adoption of suitable technologies in the mechanization of groundnut cultivation. Groundnut cultivation requires various field operations such as seedbed preparation, sowing, fertilizer application, inter-culture, harvesting and threshing (Anonymous, 2003). Mechanization of groundnut harvesting is very important field operation to increase pod recovery from the soil.

Various methods followed for harvesting of groundnut is by hand pulling, animal and tractor drawn groundnut diggers. Digging of pods by manual and animal drawn diggers from depth of 6.5 – 10 cm is laborious, time consuming and less economical. Even though tractor drawn diggers have economic and timeliness in performance compared to other methods, where crop get's spread unevenly after digging over the field and the farmers need to hire the extra labour to keep the harvested crop in small heaps or in a row for drying and for ease of transport to the place of threshing leading to increase in cost of harvesting. Moreover soil gets stick to the removed plants and pod recovery from soil is in between 85 – 90% only due to not any provision of shaking (release of soil from removed plants) and windrowing (to lay harvested crop in a row) in the available tractor drawn groundnut diggers. Hence there is a strong need to combine three operations namely digging, shaking and windrowing. For fulfilling this objective, the tractor operated groundnut digger shaker cum windrower was developed at PAU, Ludhiana (Anon, 1974) and also at AEC&RI, TNAU, Coimbatore (Duraiswamy, 1997). Later on power tiller operated groundnut digger shaker cum windrower was also developed at AEC&RI, TNAU, Coimbatore (Suryawanshi, 2008). Both of these two types of diggers have straight geometry soil cutting tool and efficient in digging and pod recovery from the soil. However, they had not become commercially popular in Andhra Pradesh for groundnut harvesting.

Keeping the above points in view, a commercially available tractor operated groundnut digger shaker cum windrower having the inverted V geometry soil cutting tool was procured and tested in the light soils for its performance at Agricultural Research Station, Anantapur.

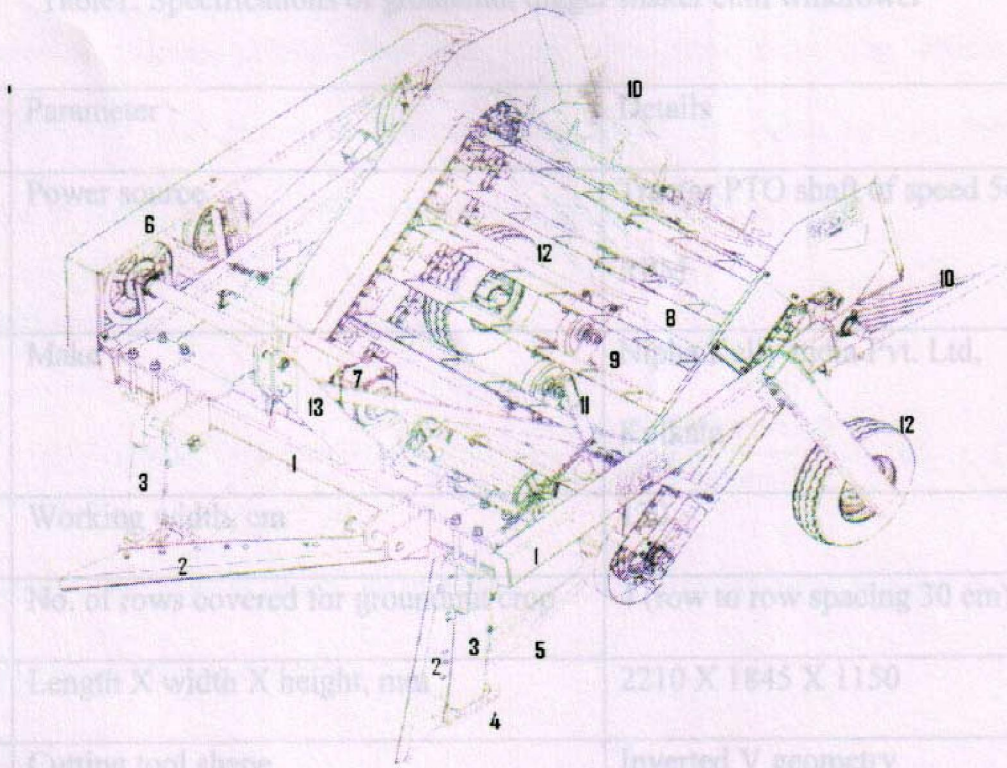


Fig.1: Schematic diagram of groundnut digger shaker cum windrower

| | | | | | | |
|---|---|---|---|---|---|---|
| Main frame | 5. | Fingers | 9. | Knocker wheel assembly | 13. | Hitch pyramid |
| Blades | 6. | Transmission unit | 10. | Windrowing rods | | |
| Standards | 7. | Gear box | 11. | Handle lever | | |
| Frog | 8. | Conveyor-shaker-windrower unit | 12. | Gauge wheel | | |

## MATERIAL AND METHODS

### Description of machine

Groundnut digger shaker cum windrower used for study can do three operations i.e digging, shaking and windrowing simultaneously while harvesting groundnut crop. It has the working width of 1200 mm and covers 4 number of rows of groundnut crop at row to row spacing of 300 mm. Its overall dimensions are 2210 x 1845 x 1150 mm provided with soil loosening tool of Inverted V geometry, a pick conveying mechanism and gatherer windrower. The soil engaging tool is made of high strength mild steel. At the rear, a gatherer windrowers the conveying crop. While conveying, soil get released from crop due to shaking action.

### Experimental procedure

The groundnut digger shaker cum windrower was tested in red soil condition. Moisture content and bulk density of soil were noted at the time of field trial. Moisture contents of both crop and pod were determined using the procedure detailed by Henderson *et al.,* (1987). The samples were dried at 130 $^0$C for 18 hours (ASAE, 2003). The depth of cut was determined by measuring the vertical distance between horizontal surfaces to bottom of furrow (Mohanty, 2005). The forward speed was measured by observing time required to travel 25 m distance with the help of stopwatch. Field capacity and field efficiency were calculated by using the following standard formulae (Mehta, 2005). The harvesting efficiency, conveying efficiency, soil separation efficiency and conveyor loss were calculated by following the methods by Suryawanshi *et al.,* (2008) for power tiller operated groundnut harvester.

### Effective field capacity

$$Effective\ field\ capacity, \frac{ha}{h} = \frac{Total\ area\ covered, ha}{Total\ time\ taken, h}\ X\ 100$$

The total time taken in above relationship includes time losses in turning and machine adjustment and breaks during operation.

### Field efficiency

$$Field\ efficiency = \frac{Effective\ field\ capacity, ha/h}{Theoretical\ field\ capacity, ha/h}\ X\ 100$$

The theoretical field capacity was determined using the following relationship:

$$TFC = WS/10$$

Where,

TFC = Theoretical field capacity, ha/h
W = Width of operation, m
S = Speed of operation, km/h

### Harvesting efficiency

$$\eta_h = \frac{W_p}{W_p + W_s}\ X\ 100$$

Where,

$\eta_h$ = Harvesting efficiency, %
$W_p$ = Weight of pods collected, kg
$W_s$ = Weight of left out pods in the soil

### Conveying efficiency

$$\eta_{pc} = \frac{(W_1 + W_2)}{(W_1 + W_2 + W_3)}\ X\ 100$$

Where,

$\eta_{pc}$ = Conveying efficiency, %
$W_1$ = Weight of plants delivered by the conveyor, kg
$W_2$ = Weight of plants remaining on the conveyor, kg
$W_3$ = Weight of unpicked and dropped plants, kg

### Soil separation efficiency

$$\eta_{ss} = \frac{(W_1 - W_2)}{(W_1 - W_2 + W_3)}\ X\ 100$$

Where

$\eta_{ss}$ = Soil separation efficiency, %
$W_1$ = Weight of plants fed at the picking end, kg
$W_2$ = Weight of plants fed at the delivery end, kg
$W_3$ = Weight of soil collected at the delivery end, kg

### Conveyor loss

$$C_1 = \frac{W_2}{W_1 + W_2}\ X\ 100$$

Where

$C_1$ = Conveyor loss, %
$W_1$ = Weight of the pods collected at the delivery end, kg
$W_2$ = Weight of pods lost in the conveyor from the plants, kg

### Conditions of soil and crop

Field conditions of soil and crop are presented in Table 2. At the time of harvesting, the soil moisture was 8.8% (db) and the soil bulk density

Table1. Specifications of groundnut digger shaker cum windrower.

| S.No. | Parameter | Details |
|---|---|---|
| 1. | Power source | Tractor PTO shaft of speed 540 RPM |
| 2. | Make | Nipha Kelly India Pvt. Ltd, Kolkata |
| 3. | Working width, cm | 120 |
| 4. | No. of rows covered for groundnut crop | 4 (row to row spacing 30 cm) |
| 5. | Length X width X height, mm | 2210 X 1845 X 1150 |
| 6. | Cutting tool shape | Inverted V geometry |
| 7. | Cutting tool material | Carbon steel |
| 8. | Rake angle | $14^0$ |
| 9. | Included angle between blades | $78^0$ |
| 10. | Weight, kg | 522 |

Table 2. Field conditions of soil and crop at the time of harvesting.

| S. No. | Parameter | Value |
|---|---|---|
| 1. | M.C. of soil, %(db) | 8.8 |
| 2. | Bulk density of soil, g/cc | 1.5 |
| 3. | Row spacing of crop, cm | 30.0 |
| 4. | Average plant to plant spacing in a row, cm | 10.4 |
| 5. | Age of crop, days | 106.0 |
| 6. | Moisture content of vines, %(wb) | 61.9 |
| 7. | Moisture content of pods, %(wb) | 45.4 |
| 8. | Pod to vine ratio | 0.5 |

was 1.5 g/cc. The moisture content of vines and pods were 61.9% (wb) and 45.4% (wb) respectively and pod to vine ratio was 0.58. The pods distribution pattern in the soil was 12.5 cm on either side of the taproot. About 93.7% of the pods were set within a periphery of 15 cm of each plant and the remaining pods were in between 15 to 20 cm of periphery.

## RESULTS AND DISCUSSION

Performance results of groundnut digger shaker cum windrower is shown in Table 3. At the starting of operation, crop harvested was not properly windrowed and some trampling of harvested plants was observed, however these two problems were rectified by placing the two plastic boards on the grills of gatherer windrower. The effective field capacity of the harvester was 0.19 ha $h^{-1}$ with the field efficiency of 67.4 %. The harvesting efficiency was 96 % with conveying and soil separation efficiencies of 97.2 % and 94 % respectively. Conveyor loss was 0.6%. Draft observed was 4.95 kW at the operating speed of 4.4 km/h. Well designed cutting tool and elevating mechanism permitted harvesting efficiency of greater than 95%. It was concluded that overall performance of the harvester was satisfactory. The fuel consumption of harvester was 4.09 l $h^{-1}$.

## CONCLUSIONS

The groundnut digger shaker cum windrower having inverted V geometry cutting tool was tested in red soil condition and found that its harvesting efficiency was 96% at the field capacity of 0.19 ha $h^{-1}$. The conveying and soil separation efficiencies were 96% and 97.2% respectively with the conveyor loss of 0.6%. Draft observed was 4.95 kW at the operating speed of 4.4 km/h. Overall performance of harvester was satisfactory and can be recommended to farmers to use.

Table 3. Performance of groundnut digger shaker cum windrower.

| S. No. | Parameter | Value |
|---|---|---|
| 1. | Effective working width of operation, cm | 120.0 |
| 2. | Draft, kW | 4.9 |
| 3. | Average operating speed, Km/h | 4.4 |
| 4. | Effective field capacity, ha/h | 0.1 |
| 5. | Field efficiency, % | 67.4 |
| 6. | Harvesting efficiency, % | 96.0 |
| 7. | Conveying efficiency, % | 97.2 |
| 8. | Soil separation efficiency, % | 94.0 |
| 9. | Conveyor loss, % | 0.6 |
| 10. | Fuel consumption, l $h^{-1}$ | 4.0 |

## LITERATURE CITED

**Anonymous 2003** Hand book of Agriculture, ICAR, New Delhi.

**Anonymous 1974** Proceedings of the VII annual workshop for research on Farm Implements and Machinery held at Ludhiana, IARI, New Delhi.

**ASAE standards 2003** Moisture measurement – ungrounded grain and seeds (S352.2FEB03). St Joseph, Michigan, 606 pp.

**Duraiswamy V M 1997** Investigations on the effect of soil, crop, machine and operational parameters in relation to mechanical harvesting of groundnut. Ph D, Tamil Nadu Agricultural University, Coimbatore.

**Henderson S M, Perry R L and Young J H 1987** Principles of Process Engineering. 4th ed., ASAE, Michigan, USA, 280 pp.

**Mehta M L, Verma S R, Misra S K and Sharma V K 2005** Testing and Evaluation of Agricultural machinery. Daya Publishing House Delhi, 56 pp.

**Mohanty D K, Das D K and Mohanty M K 2005** Performance evaluation of sweep type groundnut digger. *Agricultural Engineering Today*, 29 (3-4): 1-5.

**Suryawanshi S H, Shridhar B and Kathrivel K V 2008** Development of power tiller operated groundnut harvester. *Agricultural Mechanization in Asia, Africa and Latin America*, 39 (3): 29-32.

(Received on 17.05.2012 and revised on 23.10.2012)