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# EVALUATION OF A WALKING TRACTOR DRAWN PEANUT HARVESTER AND COMPARING IT WITH MANUAL HARVESTING

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## ABSTRACT
The object of this study was evaluation of a walking tractor drawn peanut harvester at different conditions of soil moisture content and forward speed and comparing it with manual harvesting. The evaluation factors for peanut harvester were two levels of soil moisture content and three levels of forward speed. The results revealed that the effect of soil moisture content was only significant on the percent of unexposed pods loss, while the effect of forward speed was not significant for all loss. Comparing of harvester loss at best condition with manual harvesting loss revealed that there was significant difference between two methods of peanut harvesting. Manual harvesting loss was higher than mechanical harvesting loss in the percent of exposed and unexposed pods loss. The results of this study revealed that the usage mechanical harvesting instead of manual harvesting reduces harvesting loss, harvesting costs and timeliness costs. Therefore, usage of this harvester instead of manual harvesting entirely recommended.
**Key words:** Evaluation, Forward Speed, Harvester, Peanut, Walking tractor

## 1- INTRODUCTION
Peanut (*Arachis hypogaea* L.) or groundnut, is a self-pollinating, indeterminate, annual herbaceous legume crop (Burns, 2010). Peanut also is one of the most important and economical oilseeds in tropical and sub-tropical regions. It's mostly grown due to its oil, protein and carbohydrates (Abdzad Gohari *et al.*, 2010). Nowadays, it's the fifth most important oilseed crop in the world (Burns, 2010). Peanut has several uses as whole seeds or is processed to make peanut butter, oil, and other products. The peanut seed contains 25 to 32% protein and 42 to 52% oil (Putnam *et al.*, 2013). Peanut is currently grown on over 22.2 million hectares worldwide with a total production of over 35 million tons (Rao *et al.*, 2013). Peanut was harvested when most of the leaves turned yellow and pods became hard (Arakama, 2009). It

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usually requires a minimum of 100 to 150 days from planting to maturity depending on the variety (Putnam *et al*., 2013). The digging of the soil is required for harvesting operation because peanut produces its fruit below ground. The pods (fruits) are usually located up to a depth of 7-10 cm that referred to as pod zone (Ademiluyi *et al*., 2011). The subterranean nature of fruiting in groundnut and its indeterminate growth habit makes it difficult to determine the time of maximum maturity of pods (Seutra Kaba *et al*., 2014). Immature peanuts have poor flavor, are more difficult to cure, and often deteriorate faster in storage and are more likely to be affected by undesirable mold growth. Also, the more mature peanut pods can result in the loss through weakened pegs, decay organism activity and digging losses that cause due to adverse weather (Jordan *et al*., 2008). Therefore, early harvesting decrease the yield and quality while late harvesting may increase pods loss. Heavy digging loss is unavoidable when the pegs are weakened due to over maturity or premature defoliation caused by disease, or when the soil is very dry and hard (Roberson, 2002). Therefore, the adequate labors or machinery must be existence on the harvesting time. Beside during peanut harvesting in Guilan province, due to rice harvesting in neighboring regions and non-availability of labor on time, delayed harvesting caused in heavy loss to the farmer. One of the solutions is to mechanize peanut harvesting operation. It also reduces the cost of peanut harvesting and increase profit and productivity. Iran is one of the largest producers of peanut in the Middle East (Nabavi-Pelesaraei *et al*., 2013). Its cultivation is about 3000 hectares with annual kernel production of 6,000 tons that about 2500 hectares of it located in Guilan province (Hosseinzadeh Gashti *et al*., 2009). Peanut cultivation in the Guilan province done semi mechanized. Some of early operations carried out mechanized while harvesting operation is manual yet. The major reasons for the demand for groundnut machinery are to reduce drudgery, to improve timeliness, and to increase productivity and income (Ademiluyi *et al*., 2011). Newly, a peanut harvester is made for peanut harvesting in Guilan province that only cuts main root and leaves the vines in the soil (Fig. 1). This harvester dragged by a walking tractor and the vines are easily transported upon the soil by hand. Also, number of required labor and drudgery are decrease.

**Fig. 1–** The walking tractor and peanut harvester.

The soil moisture content and forward speed have much significant effect on machine performance. Ademiluyi *et al*. (2011) evaluated the performance of NCAM developed tractor drawn groundnut digger/shaker in three levels of soil moisture content. From the obtained results, it was cleared the soil moisture content is a major factor influencing the digging efficiency of the implement and the soil moisture content between 12% - 15% will be preferable to work. Timeliness of operation is very vital in groundnut production and groundnut harvesting using the digger/shaker will produce a very low value of digging efficiency, when groundnut crops are not harvested during their right time of harvest. Also, Results showed that digging efficiency and percentage of total pod loss are inversely related to one another signifying that at lower digging efficiency there would be high percentage of total pod loss and vice versa. Ibrahim *et al*. (2008) developed a multipurpose digger for harvesting root crops and evaluated it for peanut in three levels (1.4, 1.8 and 2.3 km/h from forward speeds) and different tilt angles in three levels (12, 18 and 24 deg.), once using the vibrating movement and once without using it. The results of this study revealed developed digger can be operated efficiently under harvesting depth of 15 cm, forward speed of 2.3 km/h and tilt angle of 12 deg. with using vibrating movement. In another study, Padmanathan *et al*. (2006) designed a tractor operated groundnut combine harvester and evaluated it at different operating conditions. The results of their work revealed maximum harvesting efficiency of 92.3 percent, threshing efficiency of 82.30 percent, cleaning efficiency 72.30 percent and minimum percentage of broken pods of 4.43 was observed at 1 m width of harvester and at 1.5 km/h forward speed of operation. Also, the operation of groundnut combine harvester resulted in 39.00 and 96.00 percent saving in cost and time respectively, when compared to the conventional method of manual digging and stripping. In another paper, Dawelbeit and Wright (1999) designed a vibratory peanut digger and tested it at two soil types, two tractor speeds (2.4, 4.8 km/h), two frequencies of vibration (9, 16.7 Hz) and two amplitudes of vibration (3.2, 9.6 mm). The results revealed soil conditions, tractor speed, and amplitude of vibration significantly affected the draft but frequency not affected. Also, vibration did not significantly affect percent peanut ground losses.

The objectives of this study were evaluation of soil moisture content and forward speed effects on a walking tractor drawn peanut harvester, measuring of pods different loss at different conditions and comparing it with manual harvesting method.

## 2- MATERIAL AND METHODS

This study was conducted in Astaneh-e Ashrafiyeh county of Guilan province. The soil was loam with 43.5, 22 and 34.5 percent of silt, clay and sand, respectively. The used peanut crop for the study was planted on 29th April, 2013 and row spacing and plant spacing were 75 and 15 cm, respectively. The studied factors for peanut harvester evaluation were two levels of soil moisture content and three levels of forward speed (1.7, 2.5 and 3.3 km/h). In order to comparing of mechanical and manual harvesting methods, it was necessary to specify the best operating condition and then, the lowest pods loss compare with manual harvesting. For this purpose, the field was divided into three different experimental plots. Two plots used for evaluation of peanut harvester and third were for manual harvesting. For evaluation of peanut harvester, trials carried out on each of two plots at two days interval (145 and 147 days after planting), while manual harvesting only done at 147th day after planting. For each of moisture levels was carried out a complete randomized design with forward speed factor and three replications. Then in analysis of data, the moisture levels were integrated each other and combined analysis was performed on them. A 7 hp Kubota was used for pulling the peanut harvester, while manual harvesting was done by digging the vines from the soil by hand force. The forward speed of walking tractor was determined by taken the average time it took the tractor to cover the longest distance. The total time for each one of plots were taken to calculate the actual capacity. Also, three soil samples were taken from each plot in order to determine of soil moisture content.

The percent of damaged pods loss, exposed pods loss, unexposed pods loss and undug pods loss were determined by a sample that had taken from each of plots. A 1m2 bar was used as marked area for taking samples. The Indian standards test cods (IS: 11235 – 1985) were used for determination of this loss. The following formula was used in the computations:

$$A = B + C \quad (1)$$

$$\text{The percent of damaged pods loss} = \frac{C}{A} \times 100 \quad (2)$$

$$\text{The percent of exposed pods loss} = \frac{D}{A} \times 100 \quad (3)$$

$$\text{The percent of unexposed pods loss} = \frac{E}{A} \times 100 \quad (4)$$

$$\text{The percent of undug pods loss} = \frac{F}{A} \times 100 \quad (5)$$

Where,

A = total amount of pods collected from the plant in the sampled area.

B = amount of clean pods collected from the plant dug in the sampled area, exposed pods lying on the surface and the buried pods.

C = amount of damaged pods collected from the plants in the sampled area.

D = amount of detached pods lying exposed on the surface.

E = amount of detached pods remained inside the soil in the sampled area.

F = amount of pods remaining undetached from the undug plants in the sampled area.

## 3- RESULTS AND DISCUSSION

The average of soil moisture content is presented in Table 1. As it can be seen, the soil moisture content was decreased over time. Analysis of variance results of the data are showed in Table 2. The results revealed the effect of soil moisture content was only significant on the percent of unexposed pods loss at the 1% level, while the effect of other treatments were not significant on pods different loss (Table 2).

The lowest percent of unexposed pods loss was belonged to soil moisture content of 24.79% that was 4.998%, while the percent of unexposed pods in the soil moisture of 21.06% was 13.976%

(Fig. 2). The soil moisture content and soil resistance inversely relates to each other, therefore decreasing of soil moisture content causes increasing of soil strength and reducing of digging efficiency which cause pegs tearing and increase unexposed pods loss. Delay in harvesting after physiological maturity can result in many pods left in the soil due to weakening of pegs. Also, this case was confirmed by Singh and Oswalt (1995). It is possible to reduce this loss through harvesting at suitable soil moisture content.

Table 1- Average of soil moisture content

| Harvesting type | Soil moisture content |
|---|---|
| Mechanical harvesting (145$^{th}$ day after planting) | 24.79 |
| Mechanical harvesting (147$^{th}$ day after planting) | 21.06 |
| Manual harvesting (147$^{th}$ day after planting) | 20.55 |

Soil moisture content is based on dry.

Table 2- Analysis of variance of treatments effects on pods different loss

| SOV | df | Mean-square | | | |
|---|---|---|---|---|---|
| | | % of exposed pods loss | % of unexposed pods loss | % of undug pods loss | % of damaged pods loss |
| Soil moisture content | 1 | 0.000$^{ns}$ | 362.7$^{**}$ | 0.000$^{ns}$ | 0.003$^{ns}$ |
| Replication (s. m. c.) | 4 | 0.000$^{ns}$ | 30.41$^{ns}$ | 0.000$^{ns}$ | 0.003$^{ns}$ |
| Forward speed | 2 | 0.000$^{ns}$ | 2.554$^{ns}$ | 0.000$^{ns}$ | 0.003$^{ns}$ |
| S. m. c. × f. s. | 2 | 0.000$^{ns}$ | 33.93$^{ns}$ | 0.000$^{ns}$ | 0.003$^{ns}$ |
| Error | 8 | 0.000 | 8.834 | 0.000 | 0.003 |

$^{ns}$ and $^{**}$ is not significant and significant at 1 % probability level, respectively.

Finally the pods different loss on manual harvesting compared with similar loss on the soil moisture content of 24.79%. Mean comparison results of the pods different loss at mechanical and manual harvesting methods using t-test are showed in Table 3. As it can be seen, two harvesting methods were significant on the percent of exposed and unexposed pods loss, while they were not significant on the percent of undug and damaged pods loss. Mechanical harvesting loss was lower than manual harvesting loss on either percent of significant pods loss (Table 3). First reason for this lower loss was loosed soil which arisen from function of harvester blade. Second reason was higher soil moisture content on mechanical harvesting. Also, manual harvesting was done 2 days later that result in many pods left in the soil due to weakening of pegs.

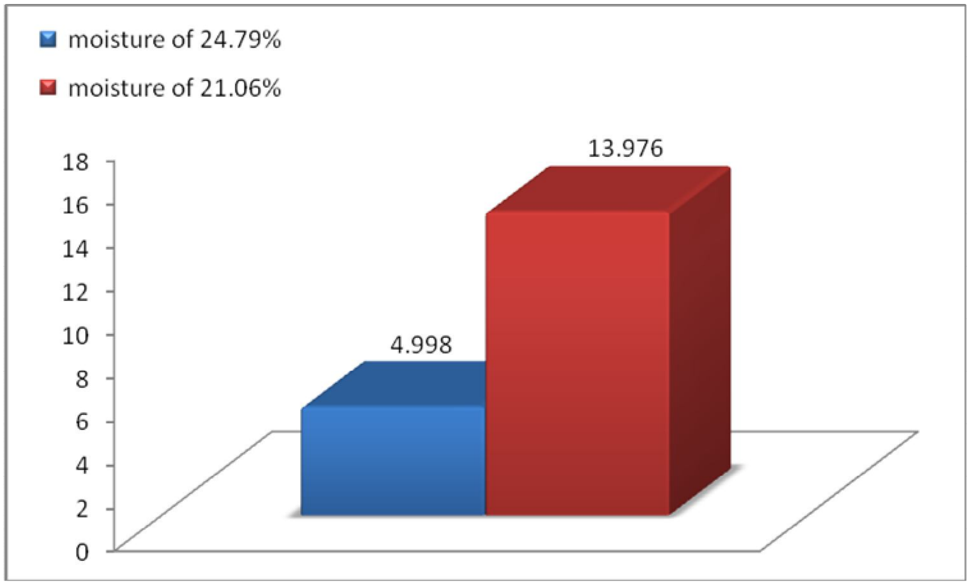

Fig. 2– The average of unexposed pods loss at soil moisture contents.

Table 3- The average of pods different loss at mechanical and manual harvesting methods

| Harvesting type | % of exposed pods loss | % of unexposed pods loss | % of undug pods loss | % of damaged pods loss |
|---|---|---|---|---|
| Mechanical | 0.000[a] | 4.998[a] | 0.000[a] | 0.000[a] |
| Manual | 10.74[b] | 24.15[b] | 0.000[a] | 0.000[a] |

The numbers of each column that have a common letter aren't significant at the 1% level.

Totally percent of pods loss on manual and mechanical harvesting were 34.89 and 4.998%, respectively. Manual and mechanical harvesting loss was calculated 2,093.4 and 299.88 kg/ha, respectively, due to the average pod average production of 6,000 kg/ha in Guilan province. Also, the loss cost of manual and mechanical harvesting was obtained 64,895,400 and 9,296,280 Rials/ha, respectively, due to average price of peanut pods was 31000 Rials/kg (Anon, 2013). Actual capacity of manual and mechanical harvesting was obtained 0.011 and 0.123 ha/h, respectively. The harvesting cost on manual and mechanical methods was concluded 6,818,182 and 1,524,390 Rials/ha, respectively, due to the labor and walking tractor cost of 600,000 and 1,500,000 Rials/day and 8 h/day. The above results showed mechanical harvesting comparing with manual harvesting reduces costs of harvesting and loss. Also, using of peanut harvester cause the operation done on time and timeliness costs is reduced. Therefore, Usage of this harvester instead of manual harvesting entirely recommended.

## 4- CONCLUSION

The results of the present study showed that soil moisture content is an important factor on the peanut mechanical harvesting that has a significant effect on the percent of unexposed pods loss. Delay of peanut harvesting increases pods loss due to weakening pegs. Therefore, harvester should be use at the proper soil moisture and time. Manual and mechanical harvesting methods were significant on the percent of exposed and unexposed pods loss that mechanical harvesting loss was lower than manual harvesting loss in both cases. Also, results revealed mechanical harvesting comparing with manual harvesting reduces harvesting loss, costs of harvesting and timeliness. Therefore, usage of this harvester instead of manual harvesting entirely recommended.

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