



## COMPARING OF PEANUT HARVESTING LOSS IN MECHANICAL AND MANUAL METHODS

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### ABSTRACT

The main purpose of this study is measuring and comparing of peanut harvesting loss in manual and mechanical methods in addition to economic analysis of them. Hence, a field was selected in Astaneh-Ashrafiyeh and divided to three different plots. Two plots were applied to measure mechanical harvesting loss and third one was applied for manual harvesting loss. According to test results, the lowest percentage of loss was belonged to forward speed of 1.8 km/ha and soil moisture content of 19.9%. The obtained data from these conditions were compared with manual harvesting data. T-test results showed all variables were significant, except percent of undug pods in 1% level of probability. The total percent of pods loss in manual and mechanical harvesting obtained 3.487 and 20.23%, respectively. The results showed the mechanical harvesting in relation with manual harvesting reduces harvesting costs and increases loss costs. Comparing of decreased and increased costs in mechanical harvesting revealed using of harvester increase overall loss and applying of it not recommended.

**Key words:** Cost, Loss, Manual Harvesting, Mechanical Harvesting, Peanut

### 1- INTRODUCTION

Peanut (*Arachis hypogaea* L.), also known as groundnut, is the third largest oilseed crop after soybean and seed cotton globally (Marfo *et al.*, 1999). Peanut produces its fruit below ground and cultivates around the world in tropical, sub-subtropical and warm temperate climates (Ademiluyi *et al.*, 2011, Stalker, 1997). It is an important source of vegetable protein and oil in sub-Saharan Africa (Marfo *et al.*, 1999). It contains good sources of vitamin E, niacin, folate and magnesium (Griel *et al.*, 2004). The oil of peanut is one of the most important vegetable oil in regions where other oily vegetables cannot grow up (Hosseinzadeh Gashti *et al.*, 2012). Peanut seeds contain 36 -

54% fat, 16 - 36% protein and 10 - 20% carbohydrate depending on the variety (Vollmann and Rajcan, 2010). Peanut's grown on nearly 24 million hectares globally with an annual production of 38 million tons (Mt) (FAOSTAT, 2012). Although it originated in South America, the vast majority of peanut is produced in Asia (68%, 23 Mt) and Africa (24%, 8 Mt), whereas the remaining (8%, 3.5 Mt) comes from North America, Caribbean countries, Europe and Oceania (Kumari *et al.*, 2014). The maturity period of peanut varies in the maximum percentage of mature fruits at harvest (Young and Mason, 1972). Mallikarjuna Swamy *et al.* (2006) reported that maintaining peanut germplasm requires harvesting at optimum maturity to obtain healthy seeds. Also, one of the most critical parts of growing peanut is timing of harvest to make maximum grade and yield (Wright *et al.*, 2009). The subterranean nature of fruiting in peanut and its indeterminate growth habit makes it difficult to determine the time of maximum maturity of pods (Seutra Kaba *et al.*, 2014). Peanut was harvested when most of the leaves turned yellow and pods became hard (Arakama, 2009). This is when it is 120 – 150 days after planting depending on the variety (Oyelade *et al.*, 2011). Delay in harvesting after physiological maturity can result in many pods left in the soil due to weakening of pegs (Singh and Oswalt, 1995). Also, late harvesting may expose the crop to field pests which cause substantial loss. Yield loss due to termites, which predominantly damaged harvested kernels was estimated at 10 to 30 % (Umeh *et al.*, 1999). Pod losses due to *in situ* sprouting of seed are substantial (20 -30 %) during late harvesting (Nautiyal *et al.*, 2001). Also, premature harvesting of peanut pods lower the yield, oil content and seeds quality due to immature pods and seeds (Singh and Oswalt, 1995). Wright and Porter (1991) further indicated that harvesting peanut too early can reduce yield by 15% and economic value by 21%. This therefore creates the need to harvest the peanut plant at an appropriate time in order to reduce yield losses (Seutra Kaba *et al.*, 2014). The amount of peanuts losses depend on the plant age and their health (Sanders and Bett, 1995, McNeill, 1996). Harvesting when 75-80% of pods have turned dark inside the shell will usually give the best grade and yield (Jordan *et al.*, 2008). 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 (Jordan *et al.*, 2013). Harvesting of peanut is very tedious, time consuming and labour intensive. The prevalent method of harvesting is mostly manual uprooting, using hand tools. In case of manual harvesting, considerable amount of groundnut pods are lost due to insufficient soil moisture or post maturity of crop (Padmanathan *et al.*, 2007). The manual harvesting can cause depletion of soil fertility due to removal of the complete root system along with nitrogenous nodules, however, this can be eliminated using mechanical harvester. The mechanical harvesting of peanut has advantage of reducing the cost and labour requirement (Ademiluyi *et al.*, 2011). 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). Some of peanut cultivation operations in Guilan province carried out mechanized while peanut harvesting is done manually yet. During peanut harvesting in Guilan province, due to rice harvesting in neighboring regions and non-availability of labor in time, delayed harvesting resulted in heavy loss to the farmer. One of the solutions is to mechanize harvesting operation in peanut cultivation. It also reduces the cost of peanut harvesting and increase profit and productivity. For this purpose, a digger/shaker/inverter machine import to Guilan province but was not so applied by farmers. The high losses during of harvesting were a reason for non-application. Ademiluyi *et al.* (2011) evaluated the performance of a tractor drawn groundnut digger/shaker in three levels of soil moisture content. The results showed soil the 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, the forward speed and conveyor slope angle are two operating conditions that have many significant effects on machine performance. 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 obtained at 1000 mm width of harvester and forward speed of 1.5 km/h. Field capacity and theoretical field capacity calculated 0.15 and 0.198 ha/h thereupon field efficiency was 75.75%. 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. Also Garg *et al.* (1990) evaluated the performance of tractor-operated groundnut diggers. The results revealed the total labour requirement in the case of the groundnut digger windrower was almost half of that of the digger with corrugated roller. Also, no appreciable difference in cost of digging (Rs 246-262/ha) was observed between the two types of mechanized digging while it was Rs 375/ha for manual harvesting.

The present study was conducted to measuring and comparing of peanut harvesting loss in both mechanical and manual methods in addition to economic analysis of them.

## 2- MATERIAL AND METHODS

This study was carried out in Astaneh-e Ashrafiyeh city of Guilan province. A total area of 0.3 hectares of silt loam soil (24% of sand, 59% silt and 17% clay) was used for the main study. The used peanut crop for the study was planted on April 22th, 2013. Row spacing and plant spacing were 75 and 15 cm, respectively. In order to comparing of harvesting loss in manual and mechanical methods, determination of harvesting machine loss in various settings was necessary. The studied factors for machine evaluation were two levels of soil moisture content (19.9 and 19.3%), three levels of forward speed (1.4, 1.8 and 2.2 km/h) and three levels of conveyor slope (35, 38 and 41 deg.). For this purpose, the field was divided into three different experimental plots. Two 810 m<sup>2</sup> plots used for evaluation of harvesting machine. Also, the third plot used for manual harvesting that it area was 1200 m<sup>2</sup>. 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. For evaluation of peanut harvesting machine, trials carried out on each of two plots at two days interval (142 and 144 days after planting), while manual harvesting only done at 140th day after planting. A Massey Ferguson tractor was used for pulling the peanut digger/shaker/inverter, while manual harvesting was done by digging the vines from the soil by shovel. Three soil samples and three pods sample were taken from each plot in order to determine of soil and pods moisture content, respectively. Forward speed was determined by taking the time in a specified distance and conveyor slope was defined by means of conveyor height and length. The total time for each one of plots were taken to calculate the actual capacity. Also, cinematic index (the ratio of the conveyor linear speed to forward speed) at different speeds was determined by measuring of conveyor linear speed.

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 1m<sup>2</sup> frame 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.

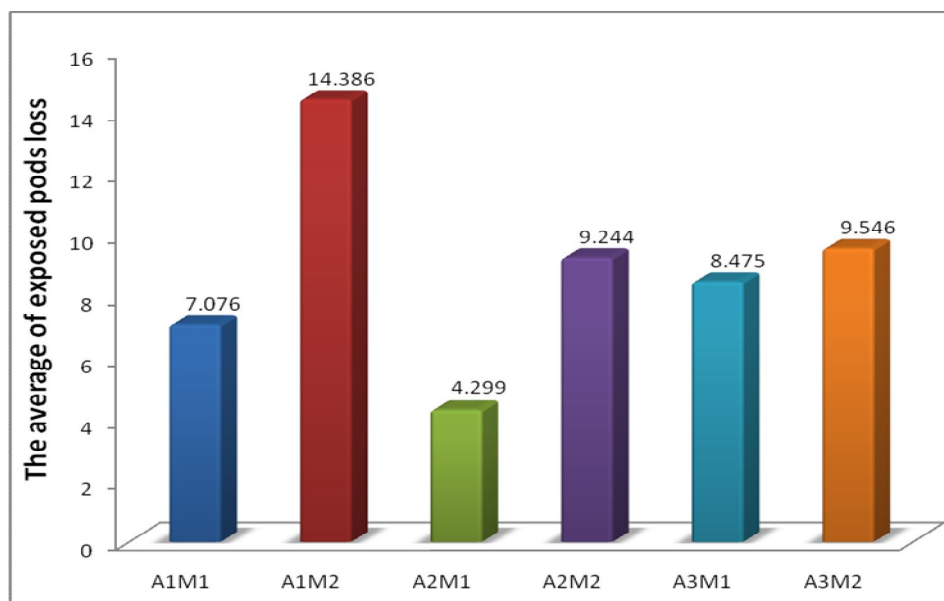
### 3- RESULTS AND DISCUSSION

The average of soil and pods moisture content is presented in Table 1. According to test results, the lowest percentage of machine loss was belonged to forward speed of 1.8 km/h and soil moisture content of 19.9% (Fig. 1). Therefore, the obtained data from these conditions were compared with manual harvesting data. Mean comparison results of the pods different loss at mechanical and manual harvesting methods using t-test are showed in Table 2. Results showed all variables were significant, except percent of undug pods in 1% level of probability. Manual harvesting loss obtained lower than mechanical harvesting loss in all variables.

Table 1- The average of soil and pods moisture content

Harvesting's type	Soil moisture content	Pods moisture content
Manual harvesting at 140 <sup>th</sup> day	18.9	49.6
Mechanical harvesting at 142 <sup>th</sup> day	19.9	48.4
Mechanical harvesting at 144 <sup>th</sup> day	19.3	46.6

Soil and pods moisture content are based on dry and wet, respectively.



**Fig. 1** - The average of exposed pods loss at different forward speeds and soil moisture contents.

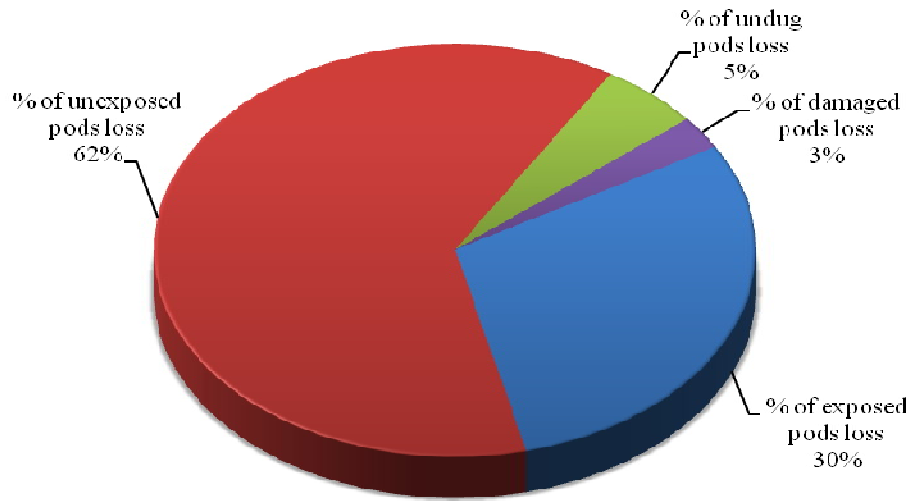
A1, A2 and A3 indicates the forward speed of 1.4, 1.8 and 2.2 km/h, respectively, also M1 and M2 indicates the soil moisture content of 19.9% and 19.3%, respectively.

Table 2- The average of pods different loss at two harvesting methods

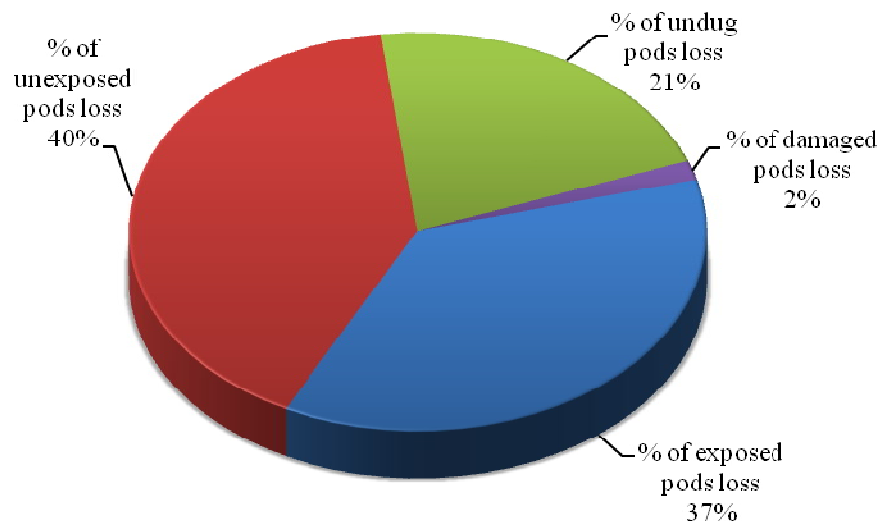
Harvesting's type	% of exposed pods loss	% of unexposed pods loss	% of undug pods loss	% of damaged pods loss
Mechanical harvesting	4.299 <sup>a</sup>	9.493 <sup>a</sup>	5.483 <sup>a</sup>	0.956 <sup>a</sup>
Manual harvesting	1.279 <sup>b</sup>	1.410 <sup>b</sup>	0.742 <sup>a</sup>	0.055 <sup>b</sup>

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

The share of pods different loss in the pods loss total of the mechanical harvesting is shown in Fig. 2. The highest percentage of the pods loss total was for the unexposed pods loss which was calculated about 62%, followed by the exposed pods loss (30%), the undug pods loss (5%) and the damaged pods loss (3%). The share of pods different loss in the pods loss total of the manual harvesting is shown in Fig. 3. The highest percentage of the pods loss total was for the unexposed pods loss which was calculated about 40%, followed by the exposed pods loss (37%), the undug pods loss (21%) and the damaged pods loss (2%).



**Fig. 2** - The share of pods different loss in the pods loss total of the mechanical harvesting.



**Fig. 3** - The share of pods different loss in the pods loss total of the manual harvesting.

The highest share of loss in both methods was belonged to the unexposed pods loss, which indicates a high rate of loss in the soil. The decrease of soil moisture content and subsequently the decrease of digging efficiency was the reason for the increase of unexposed pods loss. Also, the weakened pegs were another reason that caused pods remained in the soil. The remaining pods in the soil rapidly decay due to seasonal rainfall and high soil moisture content. Also, the again dig will be needed for digging of pods from the soil. It is possible to reduce such loss through the optimization of digging tools, using of peanut varieties that have more resistant pegs and harvesting in the optimum soil moisture content. As a result of it, the sensible reduction of the pods loss total is possible by reducing of the unexposed pods loss that was only related to the soil moisture content. Thus, the soil moisture content as harvesting must be controlled and the field must be irrigates if the soil moisture content wasn't inadequate. The share of the exposed pods in loss total was significant in both methods. Hitting the pods during harvesting operation was a reason and weakened pegs were another reason for increasing exposed pods loss. In Guilan province, the manual harvesting is commonly done when the peanuts are in the over mature while the delay of peanut harvesting results in the exposed pods loss due to weakened pegs. The pods are spread on the land in this type of loss and they are collectable using the new labour. However, it will be reasonable when the loss is high, the labor costs are low and the cost-benefit ratio is positive.

The total percent of pods loss in manual and mechanical harvesting obtained 3.487 and 20.23%, respectively. Manual and mechanical harvesting loss was calculated 209.2 and 1214 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 6,485,200 and 37,634,000 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 0.014 and 0.154 ha/h, respectively. The harvesting cost on manual and mechanical methods was concluded 5,233,050 and 1,623,370 Rials/ha, respectively, due to the labor and tractor cost of 600,000 and 2,000,000 Rials/day and 8 h/day.

The results showed the mechanical harvesting in relation with manual harvesting reduces harvesting costs and increases loss costs. Comparing of mentioned costs revealed the mechanical method increase overall costs. Also, using of peanut harvester cause the operation done on time and timeliness costs reduce but, cost of machine loss can more increase when the harvester not adjusts.

#### 4- CONCLUSION

The recent study results showed that soil moisture content and forward speed are important factors on the peanut mechanical harvesting that have a significant effect on the pods loss total. Also, the result revealed the two methods of peanut harvesting have a significant difference in the harvesting loss. Mechanical harvesting loss obtained higher than manual harvesting loss in all variables. The total percent of pods loss in manual and mechanical harvesting obtained 3.487 and 20.23%, respectively. The results showed the mechanical harvesting in relation with manual harvesting reduces costs of harvesting and increases costs of loss. Comparing of increased and decreased costs revealed the mechanical method has higher overall costs. Also, costs of loss on machine can more increase when the harvester not adjusts. The highest share of the pods loss total in both methods was belonged to the unexposed pods loss which indicates a high rate of loss in the soil.

The decrease of soil moisture content and weakened pegs were two reasons that caused pods remained in the soil.

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