Effect of Some Machine and Crop Factors on Mechanical Groundnut Threshing

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Abstract
An experiment was conducted at the Rahad Research Station, Elfau for two consecutive seasons on a groundnut combine to investigate the effect of machine factors (pick-up cylinder speed and picking cylinder speed) and crop moisture content on header and tail losses of groundnut.

Statistical analysis showed that pod moisture content has a significant effect on header and tail losses. Losses increased substantially with the decrease in moisture content (delay of threshing). The combine pick-up speed was found to have a significant effect on header losses and a little effect on tail losses. The picking cylinder speed was found to have a decisive effect on tail losses and no effect on header losses.

Introduction
Groundnut (Arachis hypogaeae L.) is an important economic crop in the Sudan. Its average contribution to the total export value in the period 1980-1985 was between 1.7 to 18.6% (Bank of Sudan, 1985). About 15% of the total area under cultivation is irrigated, producing 40% of the total crop (Ishag, 1986). Irrigated groundnut areas in the Sudan is comprised of large government projects (Gezira, Rahad, New Halfa, and Suki) where production is mechanized at various levels. The highest mechanization levels are found in Rahad Project where about 24% of the cultivated area (27,000 ha) is mechanically dug out and about 62% of the area is mechanically threshed (Ibrahim et al., 1986).

Mechanization problems faced by these projects include: lack of spare parts, inadequate training, insufficient workshop equipment, absence of support services, poor management and maintenance of machinery, selection of unsuitable machinery and poor infrastructure (Dawelbeit and Ahmed, 1987).

The objectives of this study were to evaluate the groundnut losses in the threshing operation as affected by crop and machine parameters. Parameters considered were groundnut moisture content (or time from digging), machine pick-up cylinder speed, and picking cylinder speed. Such information should help machinery management staff and operators in performing an efficient harvest operation.

Materials and Methods
The experiment was conducted at Elfau-Rahad Research Station for two consecutive seasons (1985/86 and 1986/87). The mean annual rainfall is about 470 mm, soil is vertisol with high clay content (50-60%), low organic matter (0.03%), and alkaline pH (8.78-9.4) (Fahal, 1984).

Equipment used included:
1. A Lilliston Model 5500 mounted digger-hasker-windrower with a 1.80 m digging width. This machine digs the plants, lifts them onto the shaker and finally places them on a windrow.
2. A Lilliston Model 1580, trailed (with pneumatic tires), PTO driven groundnut combine. This combine has eight basic operating groups (Fig. 1). The combine is manufactured to harvest directly from the windrow, it can be used also efficiently to harvest stacked groundnut. Five basic functions are performed by this combine. These include: pick up and feeding, picking, separation, cleaning, and conveying into a storage tank.

A split-split plot design with four replications was used. In the first season, the main plots were two levels of pod moisture content at two days and five days from digging. The sub-plots were three levels of picking cylinder speeds: 68, 75, and 80 rpm. The sub-sub plots were three levels of pick up
cylinder speeds: 69, 88, and 97 rpm. These levels of cylinder speeds represent the high, medium, and low available sprocket combinations. In the second season change had been made on the organization and levels of factors due to some difficulties encountered in the first season. The main plots were two picking cylinder speeds 68 and 75 rpm. The sub-plots were two pick up cylinder speeds 88 and 97 rpm. The sub-sub-plots were four levels of pod moisture content at intervals of zero day, four days, seven days, and ten days from digging. These variables were factorially arranged each with four replications.

Pod moisture content (w.b.) was calculated according to ASAE standards (ASAE, 1984). From each level of moisture content four samples were taken randomly, shelled, and over dried for 6h at 130°C. Soil moisture content was determined using the standard method (oven dried at 105°C for 24 h). Soil samples from five locations of the experimental area were used to estimate the average soil moisture content.

The experimental area was disc harrowed and shaped to ridges 0.80 m wide using a ridger/lister. Planting (var. MH383) was done in the first week of June at a seeding rate of 90 kg/ha using a row planter. A pre-emergence herbicide was used, followed immediately by applying irrigation water using long furrows. Resowing was done manually after about ten days. Nine subsequent irrigations were applied at fortnightly intervals. Plots were kept weed-free. Digging was performed 145 days from planting. The digger-shaker windrower was used to dig all the plots at the same time. Digging losses were estimated from ten plots randomly determined from the experimental area, as pods lost in the ground during the digging operation.

Threshing losses estimated as follows:

a. Header losses: these are pods which are left on the surface of the ground after the combine header pass.

b. Tail losses: these are pods lost with the hay thrown at the back of the combine.

c. Total threshing losses: is the sum of the header losses and the tail losses.

Combine parameters used included pick up cylinder speed and picking cylinder speed.

Results and Discussion

Data collected in this experiment was processed and an analysis of variance was performed. (More details are found in Dafalla, 1988).

Digging Losses

For the first season the mean percent digging losses were 7.7% at a soil moisture content (d.b.) of 21.1%, For the second season, mean digging losses were 8.2% at soil moisture content (d.b.) of 20.2%.

Threshing Losses

The pod moisture content, pick-up cylinder speed and picking cylinder speed affected header, tail and total threshing losses in various degrees.

Pod moisture content—In the first season the moisture content after two and five days from digging were 22.16 and 10.12% respectively. Results showed that header, tail, and total losses increased significantly (5% level) with a decrease in pod moisture content. Fig. 2 summarizes the results showing that threshing after two days is better than threshing after five days.

Mean pod moisture content (w.b.) for the second season was 36.5, 12.1, 10.0, and 3.9% for zero day, four days, seven days and ten days, respectively. Mean percent header losses increased with a decrease in pod moisture content (Fig. 5). Analysis of variance showed highly significant effect (at 1% level). Results showed also that the effect of pods' moisture content was highly significant (at 1% level) on tail losses. The mean percent losses increased with a decrease in pod moisture content. Consequently, total threshing losses increased significantly with the decrease in pod moisture content.

These results are in agreement with those obtained by Bharat et al. (1976) and Young et al. (1982) who concluded that, while the pod
moisture content is reduced in the windrow, field losses increased with increased exposure in the windrow. This also confirms what

Pothecary (1966) stated that with picking by machine the optimum time for good threshing is 2 to 3 days after lifting, further delay meant that the crop became too dry and losses increased.

**Pick-up cylinder speed**—No significant effects were observed on the effect of pick-up cylinder on tail losses in the first season. However, results showed that the pick-up cylinder has highly significant effect on header losses as well as the total threshing losses. These losses increased with the increase of the pick-up cylinder speed from 69 to 88 to 97 rpm (Fig. 3). Hence, the best pick-up cylinder speed was 69 rpm.

Although there was some increase in threshing losses in the second season with the increase of
pick-up cylinder speed from 88 to 97 rpm (Fig. 6), the results of the analysis of variance showed that there were no significant effect of pick-up cylinder on header, tail, and total losses.

These results coincided with those stated by Stokes and Reed (1950). They reported that, in order to minimize losses in the pick-up operation, it is important that the pick-up speed be synchronized with the ground speed so that the winnow flows like a ribbon from the ground, over the pick-up and into the combine. If the pick-up speed is too fast relative to the ground speed, the winnow will tear apart and strip the pods from the vines before they enter the combine.

**Picking cylinder speed**—From the analysis of variance in the first season it was found that the effect of picking cylinder on tail and total threshing losses was highly significant (at 5% level). Tail and total losses increased with increase of cylinder speed from 68 to 80 rpm (Fig. 4). On the other hand, picking cylinder speed was found to have no significant effect on header losses. Hence, a picking cylinder speed of 68 is better than 80 rpm.

In the second season there were no significant effects of combine picking cylinder speed on either head or tail losses. However, the percentage of pod losses increased significantly (5% level) with the increase in picking cylinder speed from 68 to 75 rpm (Fig. 7).

**Interaction among variables**—The results of the analysis of variance for interaction among all the variables studied in the experiment at all the levels for the two seasons showed no significance.

**Conclusions**

1. **Pod moisture content**—The effect of pod moisture content on header, tail and total losses was significant for both seasons. These losses increased with the decrease of pod moisture content. The pod losses ranged from 0.9 to 2.3%, from 0.7 to 2.5%, and from 1.6 to 4.8% for header, tail, and total threshing losses, respectively, for the two seasons. Thus the earlier the threshing the less losses are expected.

2. **Pick-up cylinder speed**—The pick-up cylinder speed showed highly significant effect on header, tail, as well as total threshing losses in the first season. However, in the second season it showed no significant differences for all mentioned losses. These losses increased with the increase of the pick-up cylinder speed. The lowest used pick-up cylinder speed (68 rpm) was the best.

3. **Picking cylinder speed**—Although the percentage of header and tail losses increased with the increase of picking cylinder speed, the increase was not statistically significant for the two seasons. However, significant effects were found in tail losses in the first season. Total threshing losses were significantly affected for both seasons. It could be concluded that the lowest picking cylinder speed used (69 rpm) was the best.

**REFERENCES**


