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Development a Locale Thresher Machine for Separating Peanut Crop

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ABSTRACT

A threshing process for peanut crop is considered one of the most essential agricultural operations. Therefore, the research aimed to develop a local threshing machine for separating and extracting the peanut pods from straw and other materials. This was done by replacing the normal concave with a new one with opening of 7×7cm per opening (square shape). The front sieve is replaced with its last holes in the form of slides, with a distance of 0.5 cm. And adjusting the clearance between the threshing drum and concave in range of 7cm for drum-type (1) and the clearance between the threshing drum and concave should be 5cm for drum-type (2), The experimental work was carried out at El Delengat district, Behera Governorate. The performance of the thresher was tested under three crop feeding rates of 15, 20, and 25 kg/min, meanwhile, four speeds for a threshing drum 300, 350, 400, and 450 rpm (10.99, 12.82, 14.65, and 16.48m/s) and two types of threshing drums were tested, drum-type (1) 44 knives with a concave clearance 7cm and drum-type (2) 22 knives with a concave clearance 5cm. The results conducted that, the highest threshing efficiency (99. 7%) was obtained by drum type (2) under 450 rpm drum speed and 15kg/min feeding rate. The modified drum type (2) showed the lowest broken pods with an average of 1.93%. The lowest required power (12.2 kW) was shown under 300 rpm drum speed and 15 kg/min feeding rate.

Keywords: thresher machine; peanut; threshing drum

INTRODUCTION

The peanut crop is considered one of the summer crops in the new lands, which are mostly sandy soil or light sandy soil, these soil types suitable for growing peanut crop. Separating pods process is considered one of the most important agricultural for the peanut crop. Due to the lack of timely labor and the high costs, the delay in the lesson process leads to a burden loss for the farmer. To relieve the labor burden during the seasons and achieve optimum timing of the operation, El-Behery *et al*., (2000) tested El-Shams rice thresher as the dual-purpose machine to obtain seeds and fiber materials from flax crop. The threshing was performed using a range of drum speeds, feed crop rates, and the lengths of conveyor chain tension at four different levels of capsule moisture contents. Results of the experiments indicated that for optimum performance the threshing drum speed, feed rate, and length of conveyor tension should be approximately 31.43 m/s, 20 kg/min and 48 mm, respectively at 18.45 % moisture content of capsules. Seed damage was not of an economic importance level (1.78%). The optimum fuel consumption values were 3.7 liter/h and 3.08 liter/ton. The average cost of flax threshing was 16.23 L.E/ton compared with 50 L.E/ton for manual threshing.

Sudajan *et al.* (2002) studied the effect of drum type, drum speed, and feed rate on sunflower threshing. They indicated that the grain damage increased with an increase in drum speed for all drums and feed rates. This increase was due to higher impact levels acting to the crop during threshing at higher drum speeds. Awady *et al.* (2003) showed that cleaning efficiency and total losses were positively affected by airspeed and sieve tilt angle, but purity was negatively affected by increasing moisture content and feed rate. The optimum performance of cleaning rice crop was at an airspeed of 4 m/sec, moisture content of 18 % and sieve tilt angle of 2 degrees, round-shape sieve, and feed rate of 1200 kg / h. The purity of these conditions was 98.98 % and a total loss was 0.21 while Yilmaz *et al.* (2008) investigated the effect of some of the threshing parameters such as Drum speed, feed rate, and concave open on closed capsules sesame straw sieve in the developed threshing unit. Threshing drums used were a rasp bar with tooth type, three threshing drum speeds of 500, 700, and 900 min^{-1} (6.5, 9.1, 11.7 m/s), three feed rate as (90, 180 & 270 kg /h), three concave open as (20, 35 and 50 mm), four sieves of mesh numbers (7, 10, 14 and 18) were used. They concluded that the 10, 14, and 18 mesh number sieves should be used for the separation of sesame stalk and grain. The design of the separation unit should depend on these sieves. The best performance of the sieves gave at 900 min^{-1} drum speed, 90 kg/h feed rate and 20 mm concave open for separation of the sesame stalk and grain.

Peksen *et al.* (2013) designed and manufactured a stationary chickpea threshing unit which evaluated with three different beater types (spike-tooth, lama-tooth, and wire loop, two different types of concave (manufactured from PVC and chrome), five peripheral speeds (8.0, 10.5, 12.5, 14.5 and, 19.0 m/s), five concave clearances (15, 20, 25, 30 and 35 mm) and four feeding rates (360, 540, 720 and 900 kg/h) they concluded that the wire loop was the best one among all beaters for threshing due to minimal seed breakage, lowest invisible injury of the seeds accompanied with high field emergence and highest threshing efficiency. Any PVC and chrome concave can be recommended for use in the threshing unit as these were not different from each other in their performance. Saeidirad *et al.* (2013) investigated the effect of cylinder speed with four levels, concave clearance, and feed rate on un-separated seed percentage, damaged seed percentage, and germination of sorghum. They concluded that the threshing cylinder speed had a significant effect on unseparated seed percentage and damaged seed percentage. The concave clearance created a

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significant effect on damaged seed percentage. Though the feed rate did not have a significant effect on all adjectives, the unseparated seed percentage increased with increasing of the feed rate. The thresher efficiency and damaged seed increased with the increase of cylinder speed. The increase of concave clearance caused the un- separated seed mass percentage to increase, and the damaged seed rate decreased.

Olaye *et al.* (2016) confirmed the effect of an axial-flow spike-tooth thresher with cylinder speed of four levels (600, 800, 1000, and 1200 rpm) and three samples of paddy mass (40, 50, and 60 kg) and three replications on productivity per hour. It is revealed that the mean threshing productivity ranged from 1326 to 2013 kg/h, mean fuel consumption ranged between 0.75 to 0.8mL/kg, threshing efficiency was 100 percent. The mechanical seed damage ranged from 2.63 to 16.45 percent. The cleaning efficiency ranged from 95.57 to 96.79 percent, while the seed loss range from 0.88 to 4.23 percent for the above mentioned four speeds. Sorghum threshing was given at the 21 m/s cylinder speed, 10 mm Drum concave clearance, and 590 kg/h feed rates. Vennela *et al* (2018) crop parameters observed during threshing were plant height was 35.68 cm with the average number of filled pods of 20.04 per plant and average the pod-vine ratio was noted as 1:4 for the K6 variety of groundnut. It was observed that at the feed rate of 870 kg h^{-1} the thresher output capacity was 227.25 kg h^{-1} with a total number of labors of 6.

Therefore the research aimed to develop a local threshing machine for separating and extracting the peanut pods from straw and other materials. This was done by replacing the normal concave with a new one with opening of 7×7cm per opening (square shape)

MATERIALS AND METHODS

The experiments were carried out at Mamdoh Farm, El Delengat district, Behera Governorate during the agriculture season 2020. The developed thresher was locally fabricated at private workshop in wehada Village, El Delengat district, Behera Governorate. The main idea is to develop a local thresher machine to separate the peanut crop pods.

Machine Description before Modification:

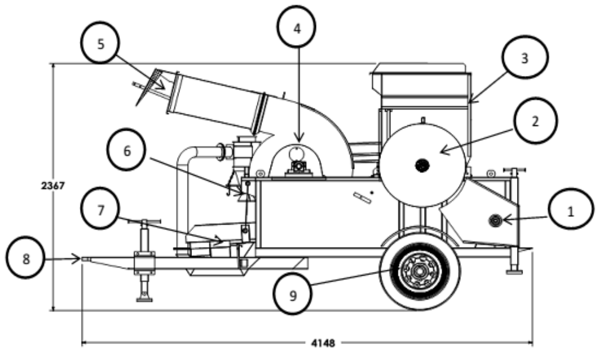
The local thresher machine, model tangential axial–flow consists of a group of parts as shown in Fig. 1. The component dimensions, drum diameter of 70 cm, drum length of 115 cm, fixed knives on 4 rows, knives total number of 44 (30 cm. long, 5cm width, and 0.7 cm thickens), and concave (118cm length, 80 cm width and 0.3cm thickens), the front sieve (115 cm length and 40cm width) drum speed ranged from 300 to 450 rpm, and the power was transmitted to thresher machine by belt pulley from 65 hp tractor

Machine Description after Modification:

Developed a local thresher machine to separate the peanut crop; peanut crop mass movement, the pods are separated from peanut plant in the threshing chamber. The peanut pods accumulated at the other end of the thresher ban. The peanut straw falls onto the sieve, where air generated by the suction fan removes the leaves and light material, the clean pods then falls through the sieve and discharged through the pods outlet. Components modified are done by replacing the normal concave with a new one with openings of 7×7 cm per opening (square shape), so that the ratio of openness to the straightened concave was 79 - 21%, respectively (118cm length,80 cm width, 0.3cm thickens, and 7×7cm holes).

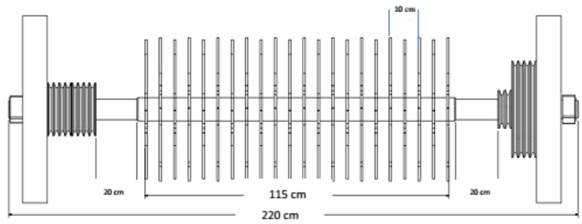
The front sieve is replaced with its last holes in the form of slides, with a distance of 0.5 cm, and the clearance between the threshing drum and concave should be 7cm for drum type (1) drum dimensions (diameter 64 cm, length 115 cm, number of beater 4, fixed knives on 4 rows and knives number 44 (27 cm. long, 10cm width, and 0.7cm thickness),

Meanwhile, clearance 5cm for drum type (2) dimensions (diameter 68 cm, length 115 cm, number of beater 4, on 4 rows, knives number 22 (29 cm. long, 20cm width, and 0.7 cm thickness, two rows consist of 6 knives and two rows of 5 knives alternately) Fan speed should be the ratio of reduction between the threshing drum and speed of the blower 1: 2.6. This modification aimed to increase thresher efficiency, maximizing the benefit of the developed local thresher, saving farmers time and effort, optimize power requirements. The performance of the modified thresher influenced by drum speed, feed rate, drum type, and suction fan air speed.

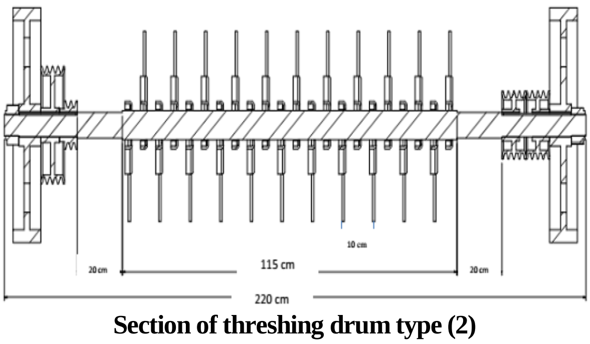


1- Sieve cam shaft 2-Crop inlet. 3- Threshing Drum.
4- Fan housing. 5- Straw Output (tibn). 6-Pods outlet .
7- Screen assembly. 8- Tow ring 9- Rubber wheel.

Fig. 1. Side veiw of thresher.



Threshing drum type (1)



Section of threshing drum type (2)

Fig. 2. View of the threshing Drum

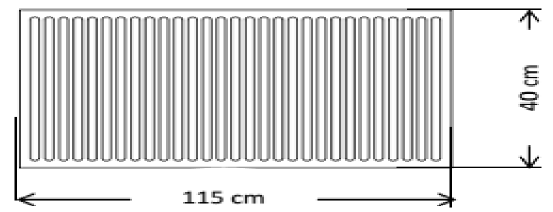


Fig. 3. View Front sieve

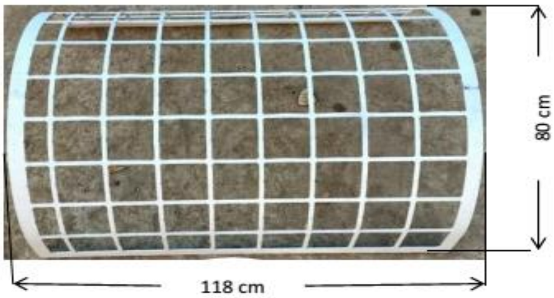


Fig. 4. Modified concave opening 7×7cm (square shape)

Test parameters

1- Four drum speeds: 300, 350,400 and 450 rpm (10.99, 12.82, 14.65, and 16.48m/s)

2- Three feed rates 15, 20, and 25 kg/min

3- Drum type: Two types of thresher drum type (1) 44 knives and concave clearance 7cm.And drum type (2) 22 knives and concave drum clearance 5cm

Experimental measurements:

Peanut crop variety Giza 6, whose height is about 60-65 cm. The pod length of 3 - 4.5 cm contains two seeds. The root is deepening to 30-35 cm, carries secondary roots, and secondary roots carry nodes, called bacterial nodes. All machine safety rules and adjustment are set before the threshing process start. The blower speed established to push air under a velocity slightly less than the terminal velocity of peanut pods for separation stem plants, leaves, and other foreign material from pods (Padmanathan, 2006). The threshing drum and blower speeds were measured by using a digital tachometer; meanwhile, the feed rate was measured by using a platform balance. A stopwatch was used to note the time of operation. To study the test parameters three samples were taken for the computation of the machine losses, cleaning efficiency, and machine threshing efficiency. The following measurements and tests were repeated three times for more accurate average data.

1- Threshing efficiency

This was taken as the ratio of the mass of pods collected from all outlets per unit time and the weight of input pods per unit time. (Padmanathan, 2006)

$$Et = \frac{Wo}{WI} \times 100$$

Where, *Et* = Threshing efficiency, %

***Wo* = mass of pods collected from all outlets per unit time, kg**

***W1*= mass of input pods per unit time, kg**

2- Cleaning efficiency

This was taken as the ratio of difference between the mass of pods and mass of foreign material collected from outlet per unit time and mass of pods collected from outlet per unit time. (Padmanathan, 2006)

$$Ec = \frac{Wm - Wf}{Wm} \times 100$$

Where, *Ec* = Cleaning efficiency, %

***Wm* = mass of pods collected from outlet per unit time, kg**

***Wf* = mass of foreign matter collected from outlet per unit time, kg**

3-Percentage of broken pods

This was taken as the ratio between mass of broken pods collected from the outlet per unit time and the mass of input pods per unit time. (Padmanathan, 2006)

$$Bp = \frac{Wb}{Wi} \times 100$$

Where, Bp = Percentage of broken pods, percent

Wb = mass of broken pods collected from outlet per unit time, kg

Wi = mass of input pods per unit time, kg

4-Determination of fuel consumption:

Fuel consumption was determined by measuring the volume consumed fuel during threshing operation.

5- Power requirements, kW:

The following formula was used to estimate the engine power according to (Hunt, 1983).

$$EP(kW) = Fc \times \frac{1}{60 \times 60} \times Pf \times L.C.V \times 427 \times \eta m \times \eta th \times \frac{1}{75} \times \frac{1}{1.36}$$

Where:

Fc: Fuel consumption L/h.

Pf: Density of fuel, kg/L (for solar = 0.85).

L.C.V: lower calorific value of fuel for solar (11000 kcal / kg).

η_{th}: Thermal efficiency of the engine (about 35 % for diesel engines).

427: Thermo-mechanical equivalent, kg.m / kcal.

η_m: Mechanical efficiency of the engine (about 80 % for diesel engines).

Experimental Design

The experiments were arranged in a factorial design with three replicates by using COSTST 6400 software. The analysis of variance was done to investigate the significance of studied variables significantly at 5%.sigificant level

RESULTS AND DISCUSSION

1- Threshing efficiency.

The presented data in Fig. 5 indicated threshing efficiency significantly affected by drum types; drum speeds, and feeding rates.

As for drum types, it was clear that modified drum's significantly effect on threshing efficiency where drum type (2) showed the highest threshing efficiency 98.62 % compared to drum type(1) (96.57%). With respect to drum speeds, the obtained results showed that threshing efficiency gradually increased with the increase of drum speed. The highest threshing efficiency (99.1%) was presented under drum speed 450rpm. On other hand, the drum speed 300rpm showed the lowest threshing efficiency with an average of 96.92%. With regard to feeding rates, the data in Fig. 5 revealed that the increase of feeding rate resulted in a decrease in threshing efficiency where the threshing efficiency was 97.86% under the feeding rate 15kg/min and decrease to 97.6% with the increase of feeding rate to 20kg/min then the threshing efficiency decrease again until reaching their lowest value (97.32%) with the increase of feeding rate to 25kg/min.

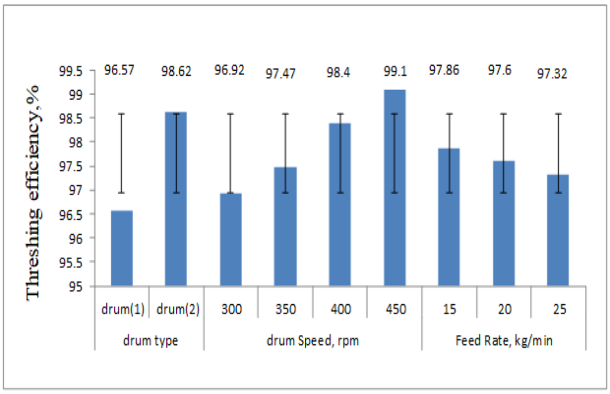


Fig. 5. Effect of drum types, drum speeds, and feed rates on threshing efficiency.

Effect of interaction of drum type, drum speed, and feeding rate on threshing efficiency, Fig. 6. Indicated that threshing efficiency significantly affected by drum type, drum speed, and feeding rate. In all cases, drum type (2) significantly exceeded drum type (1) under all drum speeds. On the other side, the result showed that the superiority of drum type (2) was observed under the lowest feeding rate. The highest threshing efficiency (99.7%) was obtained by drum type (2) under

450rpm drum speed and 15kg/min feeding rate. on contrary, the lowest threshing efficiency (95.90%) was obtained by drum type (1) by drum speed 300 rpm and 15kg/min feeding rate. The increase in the percentage of threshing efficiency by increasing drum speed was attributed to the high separating and impacting forces applied to the peanut plants, which tend to improve the threshing operation and increase threshing efficiency. On the other side, by increasing the feed rates under constant drum speed the efficiency decreased, this decrease in threshing efficiency was attributed to the excessive plants in the threshing chamber. Consequently, the stalks and their pods leave the threshing chamber incomplete threshing.

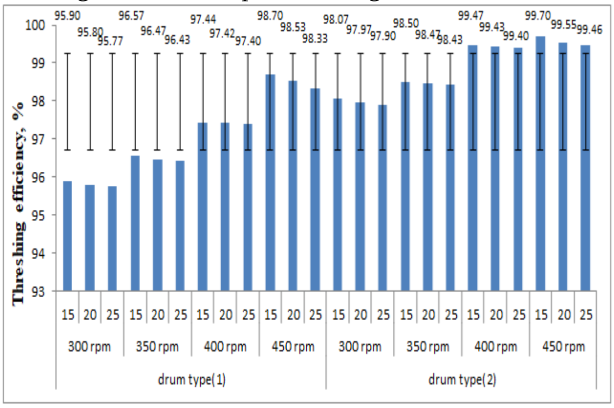


Fig. 6. Effect of interaction of drum type, drums speeds, and feed rates on threshing efficiency

2- Cleaning efficiency

The presented data in Fig. 7 confirmed that the cleaning efficiency significantly affected by drum types, drum speed, and feeding rates. With regard to drum types, the results cleared that the highest cleaning efficiency was showed under the modified drum type (2) (97.18%) compared to drum type (1) (96.23%). With respect to drum speed, the obtained data indicated that the cleaning efficiency positively associated with drum speed where increase of drum speed resulted in a large increase in cleaning efficiency. The highest cleaning efficiency (98.2%) was presented by using 450rpm as a drum speed while the lowest cleaning efficiency (95.45%) was shown with the 300rpm speed of the drum. For feeding rate, the result revealed that the cleaning efficiency gradually decreases with the increase of feeding rate where the cleaning efficiency was 97.22% under 15kg/min of feeding rate and decreased to 96.71% by increase the feeding rate to 20kg/min then cleaning efficiency decreased again until reached to their lowest value (96.19%) by increase feeding rate to 25kg/min.

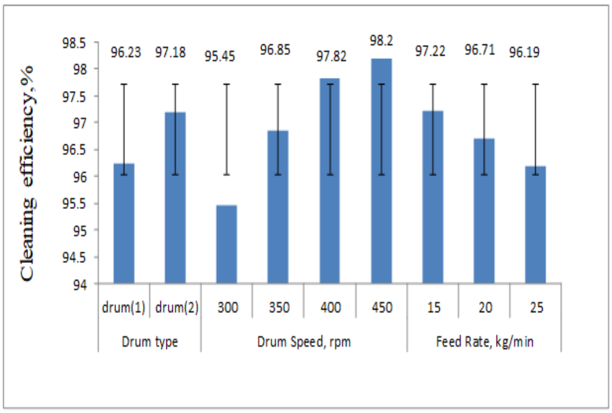


Fig. 7. Effect of the drum types, drums speeds, and feeding rates on cleaning efficiency

3 - Broken pod, %

Many factors led to crash pods such as used drum types, drum speed, and feeding rate. The obtained results in Fig. 8 showed that broken pods were significantly affected by drum type; drum speed, and feeding rate. For drum types, the obtained data indicated that the lowest broken pod percentage (2.48%) was obtained by using the modified drum type (2) compared to drum type (1) (3.50%).

Concerning drum speed, the result showed that broken pod percentage gradually increased by increasing drum speed where the broken pods percentage was 2.49% when the drum speed was 300rpm and increased to 2.82 % when the drum speed was 350 rpm and increased again to 3.66% with used drum speed of 400 rpm then the broken pod's percentage reached their peak (3.86%) by the increase of drum speed to 450 rpm.

Concerning feeding rate, the data indicated that broken pods gradually decreased by the increase of feeding rate where the broken pods percentage was 3.21% when the feeding rate was 15 kg/min and decreased to 2.96% by the increase of feeding rate to 20kg/min then decreased to their lowest percentage (2.80%) by the increase of feeding rate to 25kg/min.

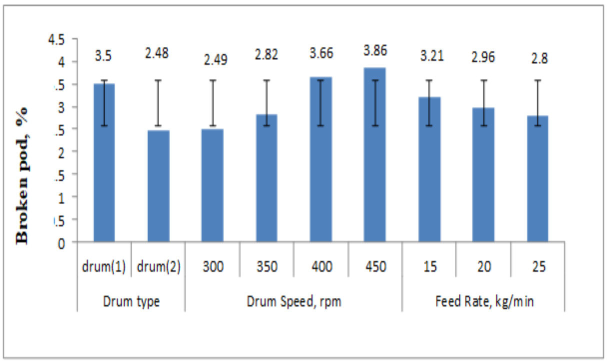


Fig. 8. Effect of the drum **types, drum speeds, and feed rates on broken pod percent**

As for the effect of the interactions between drum types, drum speed, and feeding rates (Fig. 9) on broken pods the results indicated that under all feeding rates the increase of drum speed resulted in a high increase in broken pods in both drum types. Generally used the modified drum type (2) resulted in a large decrease in broken pods compared to drum type (1). Under (300 rpm) drum speed with the highest feeding rate (25 kg/min) the modified drum type (2) showed the lowest broken pods with an average of 1.93% compared with all other interactions.

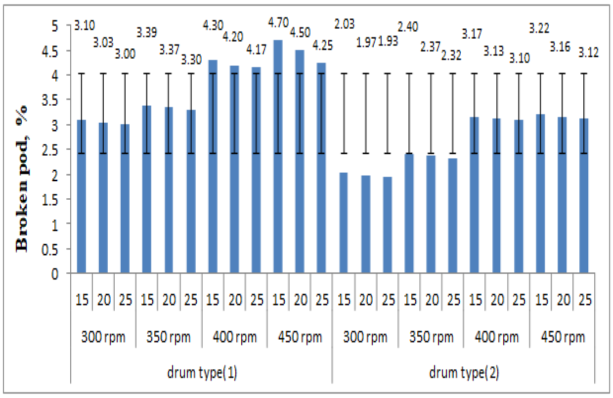


Fig. 9. Effect of interaction of the drum types, drums speeds, and feed rates on broken pod

4- Power requirement (kW).

Data presented in Fig.10. showed that power requirements for both drum types were significantly affected by drum speed and feeding rates. The drum type (2) was more efficient for saving the power requirements compared to drum type (1). The increase of both drum speed and feeding rate resulted in a large increase in the power requirements in both drum types. The lowest power requirement (12.2kW) was shown in the drum type (2) under 300 rpm drum speed and 15 kg/min feeding rate. On the other side, the highest power requirement (16.1kW) was presented in the drum type (1) when the drum speed was 450 rpm and 25 kg/min feeding rate.

This may be attributed to the decrease in weight of the threshing drum as a result of loosening a number of knives during the threshing process

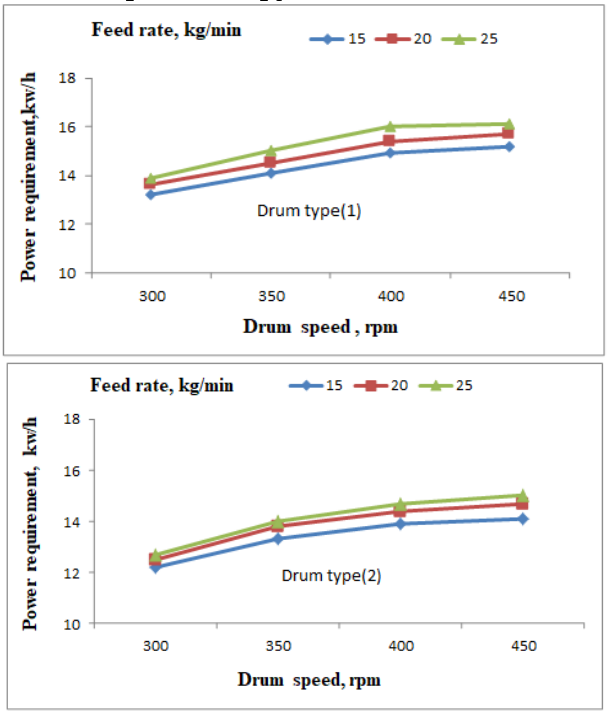


Fig. 10. Effect of drum speed, feeding rate and drum type on power requirement, (kW)

CONCLUSION

- The highest threshing efficiency (99.7%) was obtained by drum type (2) under 450 rpm drum speed and 15kg/min feeding rate. The lowest threshing efficiency (95.90%) was obtained by drum type (1) under 300 rpm drum speed and 15kg/min feeding rate.
- Under (300 rpm) drum speed with the highest feeding rate (25 kg/min) the modified drum type (2) showed the lowest broken pods with an average of 1.93%.
- The lowest power requirement (12.2) was shown in the drum type (2) under 300 rpm drum speed and 15 kg/min feeding rate

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تطوير آلة دراس محليه لفصل محصول الفول السوداني

محمد عبدالجواد احمد ابوعجيله[1]* و خميس عبدالجيد دياب[2]
[1] معهد بحوث الهندسه الزراعيه ـ مركز البحوث الزراعيه
[2] معهد بحوث المحاصيل الحقليه ـ مركز البحوث الزراعيه

تعتبر عملية الدراس لمحصول الفول السوداني من أهم العمليات الزراعية. لذلك كان الهدف من هذا البحث هو تطويراله دراس محليه لفصل وأستخلاص قرون محصول الفول السوداني عن القش والمواد الأخرى. تم ذلك عن طريق تبديل الصدر العادى بصدر جديد ذو فتحات مساحتها 7 ×7سم للفتحة الواحدة (شكل مربع). وتبديل الغربال الأمامي بأخر فتحاته على شكل شرائح ، المسافة بينهما 0.5 سم والخلوص بين أسطوانة الدرس والصدرلتكون 7 سم ، وذلك بالنسبة لدرفيل الدراس النمط الاول و5 سم لدرفيل الدراس ذو النمط الثاني. ، تم تنفيذ العمل التجريبي بمركز الدلنجات بمحافظة البحيرة. حيث تم اختبار أداء اله الدراس تحت ثلاث معدلات تغذية 15 ، 20 ، 25 كجم / دقيقة ، اربع سرعات لدرفيل الدرس 300 ، 350 ، 400, 450 لفة لكل دقيقة (10.99, 12.82, 14.65و 16.48م/ث) واستخدم نوعان من درافيل الدرس ،درفيل دراس ذو النمط (1) 44 سكينه مع خلوص للصدر7 سم ودرفيل دراس ذوالنمط (2) 22 سكينه مع خلوص للصدر 5 سم. أشارت النتائج ان أعلى كفاءة للدرس كانت (99.7٪) وذلك باستخدام الدرفيل ذو النمط (2) عند سرعه درفيل 450 لفه في الدقيقة ومعدل التغذية 15 كجم / دقيقة. أظهر الدرفيل ذو النمط (2) أقل قرون مكسورة بمتوسط 1.93٪. واقل متطلبات قدره (12.2كيلووات) عند سرعه درفيل 300 لفه في الدقيقة ومعدل تغذية 15 كجم / دقيقة