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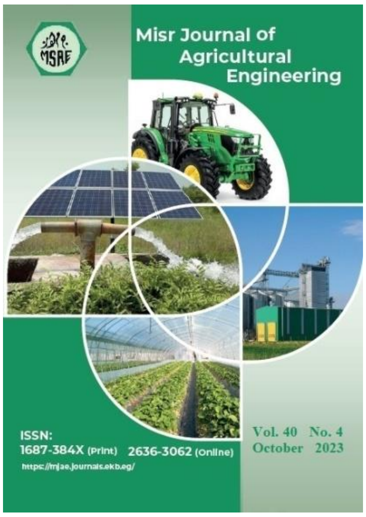
DEVELOPMENT OF A SMALL THRESHING MACHINE SUITABLE FOR WHEAT AND FABA BEAN CROPS

N. E. Mansour[1&*] and M. A. Aboegela[2]

[1] Asist. Prof. of Ag. Eng., Nat. Res. and Ag. Eng. Dept., Fac. of Ag., Damanhour U., Egypt,

[2] Senior Res., Ag. Eng., Res. Inst. Ag. Res. Center, Dokki, Giza, Egypt.

* E-mail: mohmad_abd23@yahoo.com



Keywords:
Development; Faba bean; Threshing.

ABSTRACT

The main purpose of this research is to development and evaluates a small threshing machine to suit small spaces spread in Egypt. The threshing apparatus produced at the Tanta Engine Factory (Imagro) was developed, and its effectiveness was assessed at the Itay Al-Baroud Agricultural Research Station 2020 according to two separate experiments the studied crop. The developed machine was evaluated at four levels of drum speed (350, 400, 450 and 500 rpm with faba bean - 600, 650, 700 and 750 rpm with Wheat) and three levels of feeding rate (360, 480 and 720kg/h). The Evaluation was based on the following parameters: productivity, threshing efficiency, threshing damage, cleaning efficiency, blown seed percentage, power requirements, energy consumption and costs. The results showed that increasing the drum speed improved cleaning effectiveness. under both crops and all feeding rates due to the increased rotational speed of the dust exhaust fan. The percentage of blown seeds also increased from 1.07% to 1.73% by increasing the speed of the cylinder from 350 to 500 rpm for the Faba bean crop, at a feeding rate of 720 kg / h. Consumed energy increased with the increase in moisture content, and knife speed. The results also indicated that a decreasing in the costs (LE/Mg) Productivity increased by increasing the feed rate.

INTRODUCTION

Legume (***Vicia faba L.***), which is a type of legume, is the most widely grown, produced, and consumed crop in Egypt. Because they contain 28% high-quality protein and 58% carbs, its green and dry seeds are eaten as food and processed foods. They also contain many vitamins and other nutrients, making them an agriculturally viable alternative to grain seeds, **(Singh *et al.*, 2010).** Bean productivity in Egypt is the highest in the Mediterranean region, with an average cultivated area of about 204,800 fad/year and a medium yield of 1.88 Mg/fad. Despite the fact that this crop is well grown in Egypt, (**Ministry of Agriculture 2012).**

Abo-Elnaga (1995) stated that mechanical planting with a seed drill and mechanical harvesting with a combined mower and thresher is the recommended system for Faba bean ***(Vicia faba L.)*** production under Egyptian conditions because it requires minimal cost. He added that harvesting and threshing at 14.36% seed moisture content is recommended because it minimizes seed loss.

(Desai 2004) mentions that when raking field beans, at least 25% of the pods should be discolored, whereas when mixing directly, it is recommended to wait until 90% of the pods have discolored. The moisture content of the seeds at this stage is about 30 percent or less, and that should drop to less than 20 percent when directly bonded, he added.

Wheat (***Triticum spp. L***) is one of the earliest domesticated food crops and is considered a basic staple food of the world's major civilizations. World Wheat production in 2020/2021 reaches about 772 million tons **(Shahbandeh, 2021).**

Wheat is one of the most important grain crops in Egypt. It is a winter crop grown at an average of 3.3 million feddans, with an average productivity of 18.7 ardeb per feddan. The most governorates that grow Wheat are the governorates of Sharkia, Kafr El-Sheikh, Dakahlia, and Beheira. Egyptian agricultural policy aimed to increase Wheat yield not only by increasing cultivated area but also by increasing productivity per unit area. **(G.M.A.S, *2016*).**

(El-Nakib et al. 2003) found that increased forward speed and lower grain found that header, threshing, separation, and shoe losses increased with increasing forward speed and decreasing grain moisture content. Optimal operating parameters for Wheat harvesting were a combine forward speed of 4.5 km/h and a grain moisture content of 16.5 %.

(Anwar and Gupta 1990) found that the percentage of mechanical grain damage increased with increasing cylinder speed and decreased with increasing concave clearance. Grain damage ranged from 1.6% to 2.6%. Threshing efficiency ranged from 90% to 93.1%. **(Ajav and Adejumo 2005)** found that for a given clearance and moisture content, threshing efficiency increases with increasing drum speed. They added that total losses are strongly influenced by cylinder speed, with the lowest total losses occurring at the lowest cylinder speed (4.2 m/s) and increasing with increasing speed.

(Mohamed 2001) studied the performance efficiency of fixed threshers for Wheat and rice crops and found that grain damage, grain loss, and threshing efficiency were affected by drum speed, drum and recess clearance, moisture content, and feed rate. **(Nada 1994)** compared different types of threshers for Wheat and rice and found that feed rate was directly proportional to drum speed, and that the useful power required threshing Wheat was mainly influenced by cylinder speed, with losses decreasing with increasing cylinder speed.

(Vejasit and Salokhe 2004) constructed a threshing apparatus with a peg-tooth drum and tested it at four different drum speeds, three different feed rates, and three different moisture content levels for soybeans. According to the findings, threshing efficiency ranged from 98 to 100%. Grain damage and grain loss were both less than 1.5% at drum speeds of 600 to 700 rpm, feed rates of 540 to 720 kg/h, and seed moisture values of 14.34 to 22.77% (w.b.). The maximum power requirement was 2.29 kW at 32.88% seed moisture content (w.b.) and 700 rpm drum speed. The optimal combination of feed rate and drum speed at 14.34% seed moisture content (w.b.) was 600 to 700 rpm (13.2 to 15.4 m/s) and 720 kg/h of feed rate.

(Abd El Mowla et al., 2014) A stationary thresher was enhanced by the addition of a 49 HP diesel engine and transmission. Through the threshing of two crops, Faba bean and wheat, this upgraded thresher was assessed and contrasted with the traditional thresher. According to the results, it took less time to operate the enhanced thresher (0.03 hours) than it did to connect the conventional thresher to the tractor (0.25 hours).

(Muna et al., 2016) showed that throughput is directly proportional to the number of revolutions and feed rate, but inversely proportional to moisture content; threshing efficiency is directly proportional to the number of revolutions, but inversely proportional to feed rate and moisture content; cleaning efficiency is directly proportional to the number of revolutions, but inversely proportional to feed rate and moisture content; scattered grain loss is directly proportional to the number of revolutions, but inversely proportional to feed rate and moisture content; and grain damage is directly proportional to the number of revolutions, but inversely proportional to feed rate and moisture content. Kernel damage was directly proportional to the number of rotations.

(El-Behiry et al. 1997) found a linear increase in feed rate with increasing drum speed. The feeding rate also depends on the experience of the thresher operator. As the drum speed increases, the straw size decreases and the grain loss increase. In all threshers, straw size decreases at low moisture content. **(Pandey and Stevens 2016)** investigated how well a large multi-crop thresher performed when threshing gram crops at three different cylinder speeds: 550, 600, and 650 rpm with three different feed rates: 1600, 1800, and 2000 kg/h. The results revealed that at a cylinder speed of 600 rpm and a feed rate of 2000 kg/h, the maximum threshing and washing efficiencies were 98.98% and 97.30%, respectively. On the other hand, with a cylinder speed of 550 rpm and a maximum feed rate of 2000 kg/h, the maximum total kernel loss was 3.3%. At a cylinder speed of 650 rpm and a feed rate of 2000 kg/h, grain breakage was 1.70 %. At a cylinder speed of 600 rpm and a feed rate of 2000 kg/h, the production capacity was 962 kg/h. **(Ismail et al., 2009)** noted that harvesting costs account for 35% of total machinery costs. This underscores the need to develop robust methods for selecting the best harvesting machines. **(Al-Shamiry and Yahya 2020)** The findings of an investigation into the operation of spike-tooth drum wheat crop threshers at various crop feed rates of 10, 15, and 20 kg/min and threshing drum speeds of 1400 and 1600 rpm revealed that the field capacities at these speeds were 600 and 1028.6 kg/h. highest of threshing and cleaning efficiencies of 95% were obtained for both 10 kg feed rates at the drum speed of 1600 rpm, lowest of threshing and cleaning efficiencies of 87 and 84% at the 20 kg feed rate at the drum speed of 1400 rpm, the lowest A maximum grain yield of 300 kg/hr was obtained with a 20 kg feed rate at a drum speed of 1400 rpm. The objective of this study was to development a small threshing machine and uses it for threshing of Fabe bean and Wheat suitable for low-income farmers.

MATERIALS AND METHODS

A study was conducted on a produced threshing machine at the Tanta Motors Factory (Imagro) in Gharbia Governorate, and it was developed to suit wheat and faba bean crops. It was equipped with a small 13 HP gasoline engine instead of managing it with the rear driveshaft of the farm tractor. Drum clearance of 2.5 cm was used, with two knives left in each row alternately, their clearance was 5 cm, chest slots (sieve) 15 mm, and the speed of the cleaning fan was 1.5 of the speed of the drum, for wheat. As for the municipal Faba bean, the clearance of the roller was 5 cm, leaving two knives in each row alternately, their clearance was 2.5 cm, the chest holes (sieve) were 27 mm, and the speed of the cleaning fan was 2.6 of the speed of the drum. The performance on the machine was evaluated at the Agricultural Research Station in Al-Buhaira Governorate for both during season 2020.

- Stop watch: of 0.01 sec. to record the time of threshing.
- Tachometer: (Cole-parmer 8204), ranged from 50 to 20000 rpm, resolution 1 rpm to calculate the rotating drum speed.
- Electric balance: of 0.01 g as accuracy.
- Electric oven: to estimate the moisture content.

Experimental Crops: -

- A variety of Faba bean (Improved Giza 716) and Wheat (Sakha 95)

Description of the threshing machine:

Table (1) shows the technical specifications of the threshing machine, and Figure (1) shows the external dimensions of the initial threshing model. Figure (2) shows the transmission of movement from the motor to the various parts. (**El-Fakhrany, and Aboegela2021).**

Table 1: the manufactured threshing machine's specifications

Item	Specification	Item	Specification
Total length, cm	278.7±	Drum type	Beater knives
Total width, cm	147±	Drum length, cm	75 ±
Total height, cm	184.2±	Drum diameter, cm	51 ±
Total weight, kg	750±	Number of Drum knives to fan	32 ±
Threshing chamber width, cm	80	speeds ratio	2:3
Engine power, hp	13±		

Machine Modifications:

- For ease of operation and cost savings, install a fixed engine of appropriate power. Previously, the machine was operated by the rear drive shaft of the tractor.

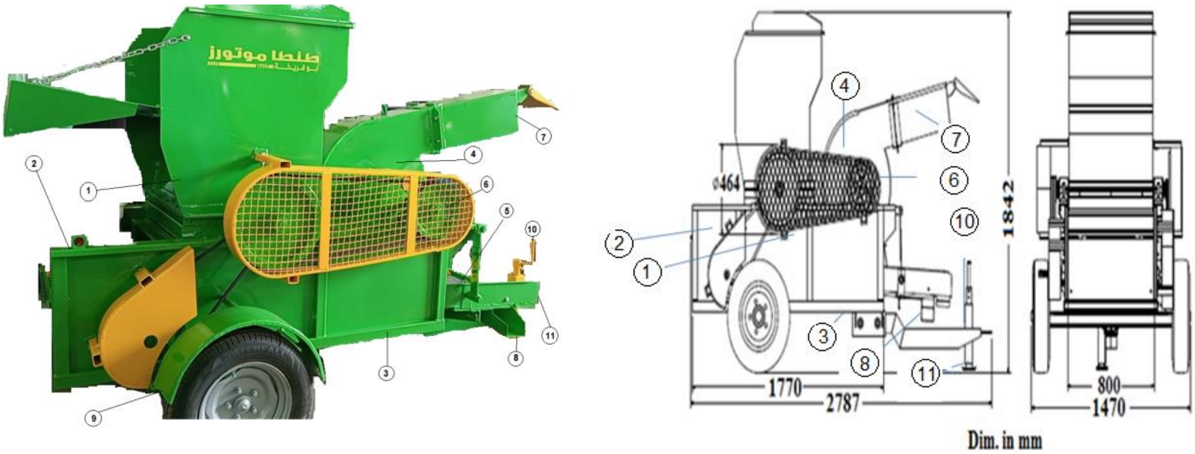
- The clearance between the drum and the concave was adjusted and the appropriate size of the breast opening was individually selected for each crop, depending on seed size, appropriate speed, feed rate, and moisture content.

Experimental procedures:

Samples were taken from each crop immediately prior to threshing operations and the moisture content of the entire plant was estimated in an electric furnace; the average moisture content per plant was 11.5% for Faba bean and 12% for Wheat.. Table (2) shows the experimental design for evaluating the machine.

Table (2): Experimental design for evaluating the machine.

Variables	Levels
Bean	
Cylinder speed, rpm (m/s)	350 (9.35), 400 (10.66), 450 (12.02) and 500 (13.35)
Feeding rates, kg / h	360, 480 and 720
Wheat	
Cylinder speed, rpm (m/s)	600 (16.01), 650 (17.34), 700 (18.67) and 750 (20.01)
Feeding rates, kg / h	360, 480 and 720



1- Threshing chamber   2- Engine   3- Main frame
4- Chaff suction fan   5- Vibrating sieve   6- Belts caver
7- Chaff outlet   8- Seed outlet   9- Sieve pulley
10- Tilt adjustment screw   11- Hitch point

Fig. (1): Dimensions and pictures of the machine

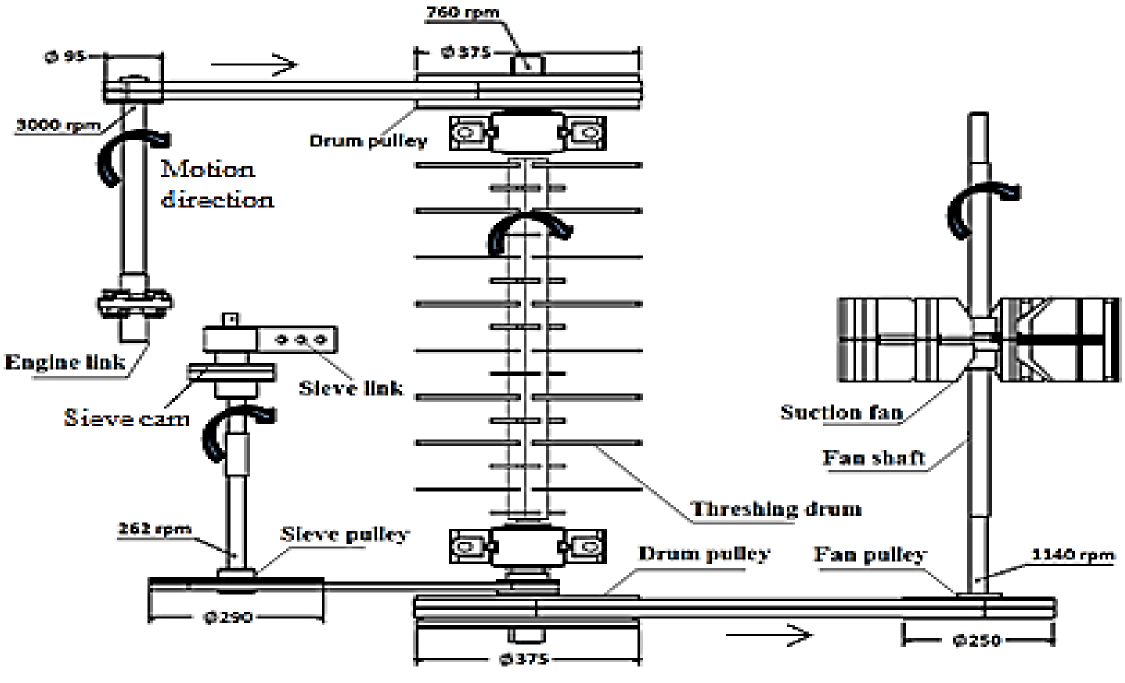


Fig. (2): Motion transmission (El-Fakhrany, and Aboegela 2021)

Design calculations:

The diameter of the drum and the clearance between the drum and concave, and also the size of concave openings has an effect on the threshing process. The number and arrangement of his nail teeth Direct impact on lesson performance indicators of threshing, and broken grain rate. Determines work quality and productivity Machine. The nail teeth design is evenly arranged in 4 rows. It is fixed on the drum, so that the number of knives in each row is 8 when the crop hay enters the threshing machine chamber through the hopper, the nail teeth rotate and Stirring straw plants.

Drum clearance of 2.5 cm was used, with two knives left in each row alternately, their clearance was 5 cm, chest slots (sieve) 15 mm, and the speed of the cleaning fan was 1.5 of the speed of the drum, for wheat. As for the municipal Faba bean, the clearance of the roller was 5 cm, leaving two knives in each row alternately, their clearance was 2.5 cm, concave holes (sieve) were 27 mm, and the speed of the cleaning fan was 2.6 of the speed of the drum.

To avoid problems during machine operation, a design study was conducted to identify the appropriate design parameters, strengths, and dimensions of materials for various elements of the machine.

To determine the capacity of a plants thresher, you will need the diameter of the thresher. This was determined using the standard formula for calculating the volume of a cylinder (see Equation 1 and Equation 2).

$$v = \frac{\pi d^2}{4} L \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$d = \sqrt{\frac{4v}{\pi L}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where;

V = volume of the threshing drum, d = diameter of the cylinder (m), L = length of the cylinder

Equation 3 is used to get the cylinder length. as reported **by (Kepner et al. 1978)**:

$$q = q_o \,.\, L.\, M \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where:

L = Drum length (m), q = Feed rate of thresher (kg/s), q_o = Permissible feed rate (kg/s) and M = Number of (rows of) beaters.

Threshing speed refers to how quickly the blades strike and graze the heads of the Faba bean pods.

If the threshing speed is too high, the seeds will burst oreven explode, making them unusable.

A threshing speed that is too slow will result in inadequate separation of the seeds.

Threshing speed is given by Equation 4:

$$v_t = \frac{2\pi N r}{60} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where:

v_t= threshing velocity; r = radius of threshing drum; N = speed of shaft r/min.

Performance evaluation:

Wheat and Faba bean crops were evaluated for productivity, threshing efficiency, cleaning efficiency, damaged seeds, and total losses.

1- Threshing efficiency, (η_T):

For each treatment, the un-threshed pods were collected and their seeds separated manually and weighted, the threshing efficiency was calculated as following:- **(El-Fakhrany, and Aboegela 2021)**

$$\boldsymbol{\eta_T = 100 - \left(\frac{W_U}{W_T} \times 100\right)}, \quad \% \ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{5})$$

Where; W_U is mass of un-threshed seeds (g) and W_T is mass of total seeds (g).

2- Threshing damage, (D):

The percentage of threshing damage was calculated from the following equation: **(El-Fakhrany, and Aboegela 2021)**

$$D = \frac{W_d}{W_T} \times 100, \quad \% \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where; W_d is mass of damaged seeds (g), and W_T is mass of total seeds (g)

3- Cleaning efficiency, (η_C):

The following equation was used to calculate cleaning efficiency: **(El-Fakhrany, and Aboegela 2021)**

$$\eta_C = \frac{W_a}{W_b} \times 100, \quad \% \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where: W_a is the seed mass after cleaning (g), W_b is the seed mass before cleaning (g)

4- Blown seed % , (Bs):

Blown seed percentage (seeds outside with straw) was calculated as the following:

$$Bs = \frac{G}{A} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where: G = mass of clean seed collected at chaff outlet per unit time (g),

A = mass of clean seed collected at seed outlet per unit time (g).

5- Productivity (P_r):

The machine productivity was calculated as following:

$$Pr = \frac{W_T}{t} \quad \textbf{(Kg/h)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Where: P_r is Machine productivity, kg/h, and t is the required time per hour to accomplish the threshing operation.

W_T is mass of total yield, kg, T = the time consumed in threshing operation h.

6- Power requirements and specific energy consumption

Fuel consumption was measured with a calibration cup specially set up for direct reading after each treatment. The required output was calculated from the formula in **(El-Fakhrany, and Aboegela 2021) (Embabie 1985)**:-

$$P = \frac{Fc \times \rho_f \times L.C.V \times 427 \times \eta_m \times \eta_{th}}{3600 \times 75 \times 1.36}, \quad kW \ldots\ldots\ldots (10)$$

Where:

P	= the required power, kW;
F_C	= consumed fuel, *l*/h;
ρ_f	= fuel density 0.72 kg/*l* for gasoline;
L.C.V	= lower calorific value of fuel, 10000 kcal/kg;
427	= thermo mechanical equivalent, kg.m/kcal;
η_m	= mechanical efficiency of Otto engine, 85%;
η_{th}	= thermal efficiency of Otto engine, 25%.

The specific energy consumption (kWh/Mg) was calculated by dividing the required power (kW) by the threshing machine productivity (Mg/h).

7- Costs:

The costs of threshing operation (L.E/h) were determined using the following equation, (**Hunt, 1983**), and then divided by the productivity (Mg/h). **(El-Fakhrany, and Aboegela 2021)**

$$C = \frac{P}{H}\left[\frac{1}{y} + \frac{i}{2} + T + R\right] + [0.9\, W.S.F] + \frac{M}{144}, \qquad \frac{L.E}{h}, \ldots..(11)$$

Where: –

C = hourly cost, L.E/h;

H = yearly working hours, h/year;

i = interest rate /year;

R = repairs and maintenance ratio;

W = engine power, hp;

F = fuel price, L.E/*l*;

144 = reasonable estimate of monthly working hours.

P = the estimated price of the threshing machine, L.E;

y = life expectancy of the machine, year;

T = taxes and overheads ratio;

0.9 = factor accounting for lubrications;

S = specific fuel consumption, L/h.hp;

M = monthly average wage, L.E.

RESULTS AND DISCUSSION

1- Threshing efficiency

In all cases, threshing efficiency increased by increasing drum speed and decreased by increasing feed rate for both crops in the case of Wheat. As shown in Figure (3), threshing efficiency increased with increasing speed of drum at all feed rates. By increasing the drum speed from 600 to 750 rpm, the efficiency threshing increased from 96.6 % to 99 % and from 98.2% to 99.4% at 720 and 360 kg/h feed rate respectively.

Figure (4) shows that the highest threshing efficiency of faba bean was 98.5%, at 500 rpm drum speed and 360 kg / h feed rate. On the other hand, the lowest value was 95.1%, with speed of drum 350 rpm and a feed rate of 720 kg / h.

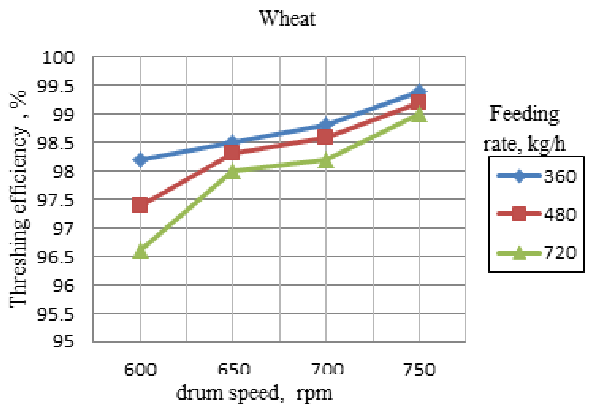


Fig.3: Effect of drum speed and feeding rate on the threshing efficiency with Wheat.

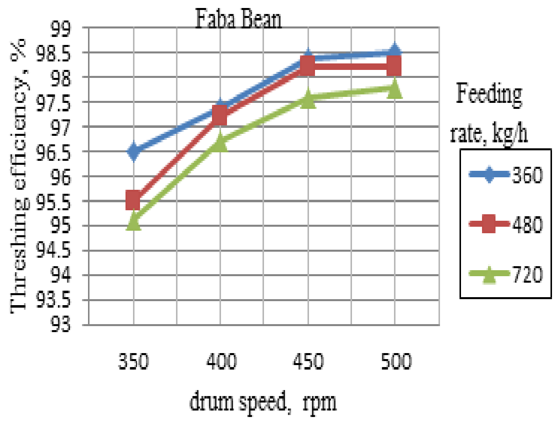


Fig.4: Effect of drum speed and feeding rate on the threshing efficiency with Faba bean.

2- Threshing damage

As shown in Figures (5) and (6), increasing speed of drum and decreasing feed rate increased seed damage in wheat and faba bean. Increasing speed of drum from 600 rpm to 750 rpm increased threshing damage in wheat from 2.17% to 3.6% at 360 kg/h feed rate. On the other hand, for faba bean, it increased from 1.97% to 3.47% at the same feed rate. The highest value of 3.6% seed loss for wheat was obtained at a drum speed of 750 rpm and a feed rate of 360 kg / h. On the other hand, the lowest value of seed loss for Faba bean was 1.73%, obtained at a speed of drum of 350 rpm and a feed rate of 720 kg / h.

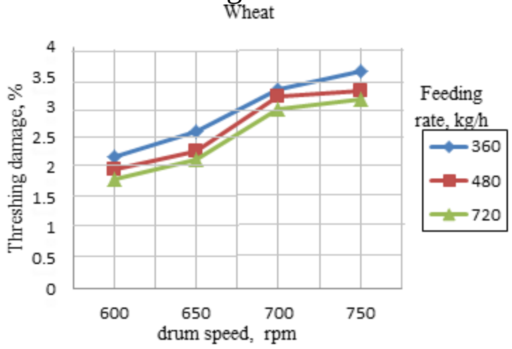


Fig.5: Effect of drum speed and feeding rate on the threshing damage with Wheat.

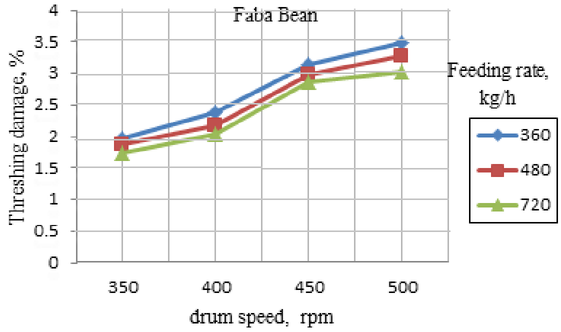


Fig.6: Effect of drum speed and feeding rate on the threshing damage with faba bean.

3- Cleaning efficiency

When the drum speed was increased from 600 rpm to 750 rpm, cleaning efficiency increased from 96.7% to 98.8% at feed rate of 360 kg/h in the case of Wheat. When the drum speed was increased from 350 rpm to 500 rpm at the feed rate of 360 kg/h, the cleaning efficiency increased from 96.5% to 98.5%in the case of Faba bean. Conversely, increasing the feed rate decreased crop cleaning efficiency at all drum speeds due to the increased load on the straw suction fan.

Highest values of cleaning efficiency for wheat and faba bean were 98.8% and 98.5%, respectively, obtained at the highest drum speed and 360 kg/h feed rate. Lowest values were 95.3% and 95.1%, which were obtained at the lowest cylinder speed and feed rate of 720 kg/h.

Figures (7) and (8) show the cleaning efficiency of the wheat and faba bean threshers. As the rpm of the threshing cylinder is increased, the rpm of the chaff suction fan is also increased. For both crops and all feeding rates, cleaning efficiency increased when the drum rotation speed was increased, because the rotation speed of the dust exhaust fan also increased.

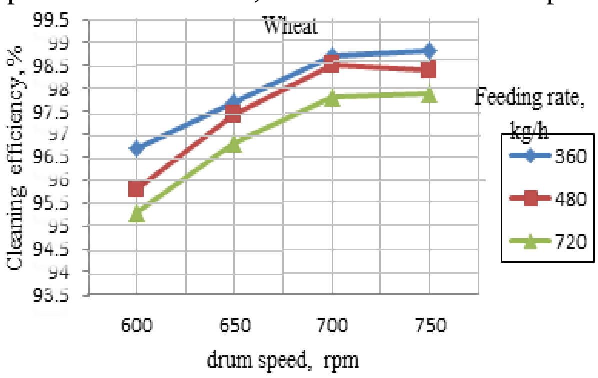


Fig.7: Effect of drum speed and feeding rate on the cleaning efficiency with Wheat.

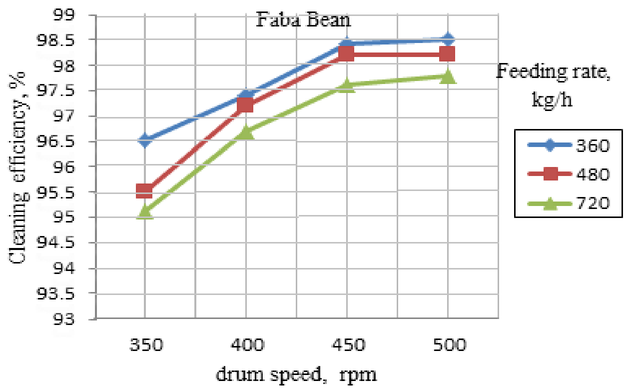


Fig.8: Effect of drum speed and feeding rate on the cleaning efficiency with faba bean.

4- Blown seed percentage

It is clear from Figure (9) that increasing the drum speed from 600 to 750 rpm increased the percentage of blown seeds in wheat from 1.4% to 2.23% at a feeding rate of 360 kg / h, while increasing the feeding rate from 360 kg / h to 720 kg / h decreased the percentage of blown seeds at all drum speeds. While, the percentage of blown seed also increased from 1.07% to 1.73% with increased from 350 to 500 rpm at a feeding rate of 720 kg / h in the case Faba bean.

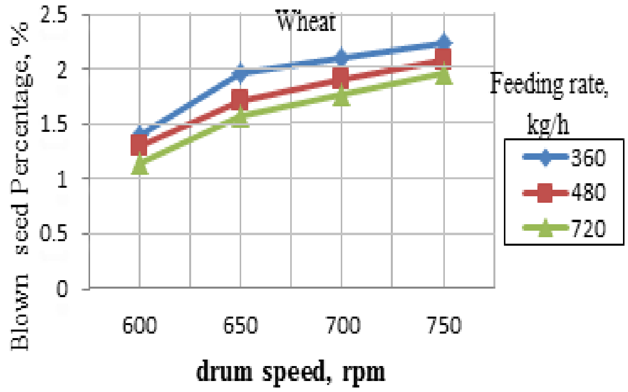


Fig.9: Effect of drum speed and feeding rate on blown seed percentage with Wheat.

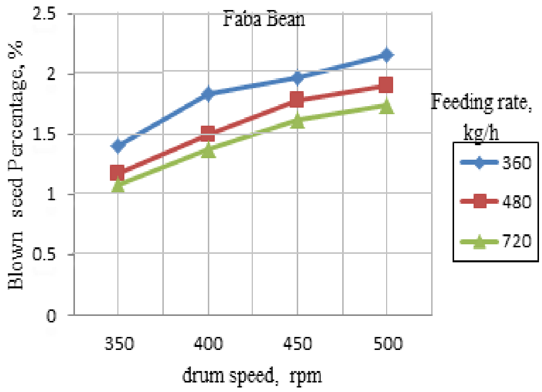


Fig.10 Effect of drum speed and feeding rate on blown seed percentage with faba bean.

5- Power requirement

As shown in Figures (11) and (12), energy requirements increased with increasing drum speed for the both crops at all feeding rates. In the case of wheat, increasing the drum speed from 600 rpm to 750 rpm at feeding rates of 360, 480, and 720 kg/h increased the power requirements from 4.35, 5.22, and 5.98 kW to 6.19, 7.21, and 7.81 kW, respectively, while for faba bean, increasing the drum speed from 350 rpm to 500 rpm increased from 4.43, 5.31, and 6.01 kW to 5.68, 6.42, and 7.03 kW, respectively. This was due to the increase in drum speed resulting from the increased fuel consumption rate.

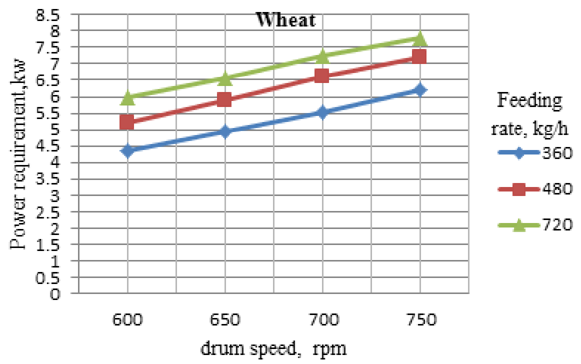


Fig.11: Effect of drum speed and feeding rate on the power requirement with Wheat.

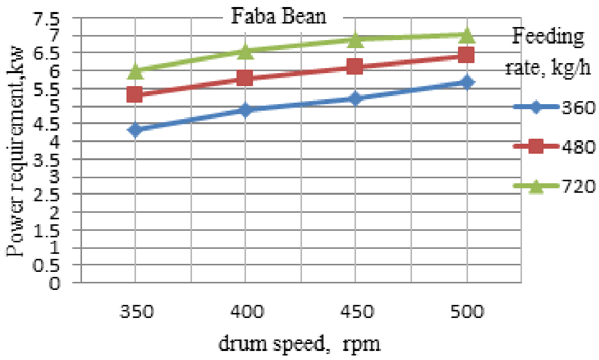


Fig.12: Effect of drum speed and feeding rate on the power requirement with faba bean.

The energy requirement also increased when the feed rate was increased from 360 kg/h to 720 kg/h. This was due to the increase in fuel consumption rate. The power required to thresh wheat increased from 4.35, 4.92, 5.52, and 6.19 kW to 5.98, 6.58, 7.25, and 7.81 kW when the feed rate was increased from 360 to 720 kg/h at speed of drum 600, 650, 700, and 750 rpm, and also for faba bean from 4.43, 4.88, 5 .20, and 5.68 kW to 6.01, 6.55, 6.89, and 7.03 kW. The highest power required to thresh wheat was 7.81 kW, at a speed of drum 750 rpm and an input rate of 720 kg/h. The highest power required to thresh Faba bean was 7.81 kW, at a drum speed of 750 rpm and feed rate of 720 kg/h. On the other hand, lowest power requirement for threshing was 4.43 kW, with a speed of drum of 350 rpm and feed rate of 360 kg/h. Highest power requirement for threshing wheat was 7.81 kW, with a drum speed of 750 rpm and feed rate of 720 kg/h.

6- Specific energy Consumption

A figure (13) and (14) shows the specific energy consumption (kWh/Mg) for both crops at different drum speeds and feed rates. As shown, increasing the drum speed due to the increased energy demand increased the energy expenditure of both crops at all feed rates. The highest energy consumption of the Faba bean and Wheat thresher was 53.09 and 61.9 kW.h/Mg respectively, at a feed rate of 360 kg/h, while lowest consumption was 34.34 and 37.38 kW.h/Mg. Faba bean and wheat, respectively, and was obtained at a feed rate of 720 kg/h.

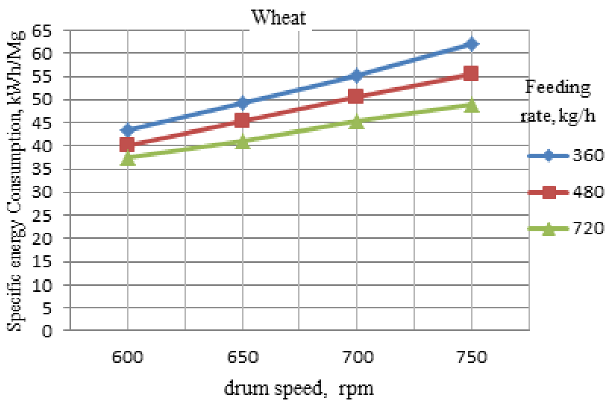


Fig.13: Effect of drum speed and feeding rate on the consumed energy with Wheat.

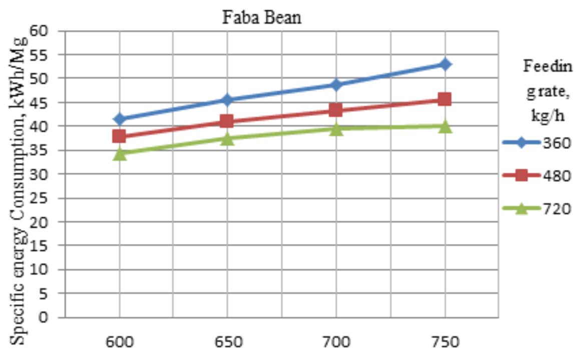
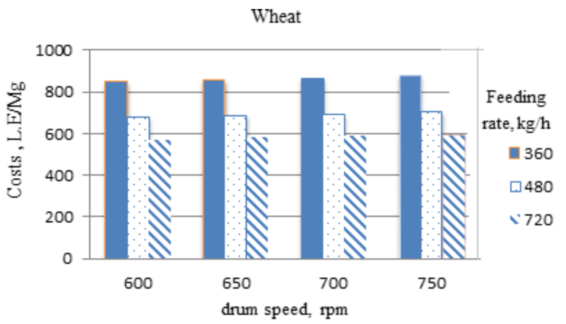


Fig.14: Effect of drum speed and feeding rate on the consumed energy with faba bean.

The specific energy consumption was increased from 41.40, 37.66 and 34.34 kWh/Mg to 53.09, 45.53 and 40.17 kWh/Mg by increasing the drum speed from 350 to 500 rpm when threshing Faba bean at feed rate of 360,480 and 720 kg/h and also, increased by 43.5, 40.15 and 37.38 kWh/Mg at 61.9, 55.46 and 48.81 kWh/Mg by threshing the Wheat at increasing the drum speed from 600 to 750 rpm. The results obtained also showed that increasing the feed rate decreases the specific energy expenditure.

7- Costs

The expenses cover the threshing machine's fixed and operational costs.. As shown in figures 15 and 16. The private cost of the Wheat threshing machine ranged from 572.8 to 878.5 LE/Mg. The cost of Faba bean threshing ranged from 615.2 to 956.7 LE/Mg. The results also showed a significant decrease in private cost (L.E/Mg) with an increase in feed rate due to the increase in productivity (Mg/hr) Wheat and Faba bean. Threshing cost decreased from 878.5 to 596.3 L.E/Mg respectively from 956.7 to 628.7 L.E/Mg, increasing feed rate from 360 to 720 kg/h. And also; Figures 15 and 16 show that private costs increase relatively little when drum speed increases at all feed rates for both crops. This is due to the increased operating costs.



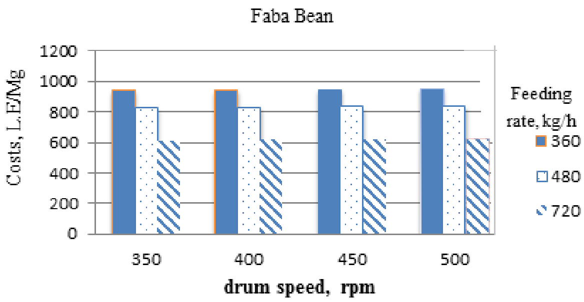


Fig.15: Effect of drum speed and feeding rate on costs with Wheat.

Fig.16: Effect of drum speed and feeding rate on costs with faba bean.

CONCLUSION

The results obtained can be summarized as follows:

1. Cleaning efficiency was increased by increasing the drum speed at all feed rate by increasing the exhaust fan speed.

2. The proportion of blower seeds percentage also increased from 1.07% to 1.73% by increasing the cylinder speed from 350 to 500 rpm to grow Faba bean at a speed of 720 kg/h.

3. Energy consumption increases with increasing drum speed.

4. The results also showed that the decrease in cost (LE/Mg) with increasing feed rate is due to the increase in productivity (Mg/h).

REFERANCES

Abd El Mowla, M.A.; M.H. Dahab; F.A. El Mahie and F.E. Abdallah (2014). Improvement and performance evaluation of stationary combine thresher. International Journal of Engineering & Scientific Research. 2(11): 40-51.

Abo Elnaga, M.A. (1995). Mechanization of balady bean crop in small holding under Egyptian conditions M.Sc. Thesis, Fac. Agric., Zagazig Univ., Egypt.

Ajav, E.A. and B.A. Adejumo (2005). Performance evaluation of an okra thresher. Agr. Eng. International: the CIGR Journal. Manuscript PM 04006 Vol. VII. October.

Al-Shamiry, F.M.S. and N.M.A. Yahya (2020). The performance evaluating of thresher machine attached to the tractor. IJRDO - Journal of Agriculture and Research. ISSN: 2455-7668. 6(3): 7-16.

Anwar, M. T. and C. P. Gupta (1990). Performance evaluation of chick pea thresher in Pakistan. AMA, 21 (3) : 23 – 28.

Desai, B.B. (2004). Seeds Handbook: Biology, production, processing and storage, Ed 2nd, Marcel Dekker Inc., New York, USA, 184- 185.

El-Behiry, A.A.; M.I. ward and A.M. El-Sherbieny (1997). Performance evaluation of some Wheat thresher machines under different conditions. Misr J. Ag. Eng., 14(4): 149-160.

El-Fakhrany, W. B. and M. A. Aboegela (2021) Manufacture and Development of a Small Threshing Machine. J. of Soil Sciences and Agricultural Engineering, Mansoura Univ., Vol. 12(3):117-122.

El-Nakib, A. A; Z. Y. Abdel-Lateef, A. A. El-Messery and A.Khattab (2003). Mechanical harvesting losses in rice crop using combine harvester. Misr J. Ag. Eng., 20 (4): 889-907.

Embabie, A.T. (1985). A comparison of different mechanization systems for cereal crop production. Unpub. M.Sc. Thesis. Agr. Eng. Dept.; Fac. of Agr., Cairo Univ., Egypt.

Hunt, D. (1983). Farm power and machinery management. 8th Edition, Iowa state Univ., Ames, U.S.A.

Kepner, R. A; K. Bainer and E. L. Barger (1978): Principles of farm machinery. AVI Publishing Company Inc., Westport.

Ismail, Z.E.; M.M. Ibrahim and S.A. Embaby (2009). Economic evaluation and selection of farm machinery. Misr J. Ag. Eng., 26(4): 746-757

Ministry of Agriculture and Land Reclamation (2012). Cropping area and production of winter crops (2002-2001), No. (5-3), Cairo, Egypt.

Main Department of Agricultural Economics (G.M.A.S) 2016 Agricultural Estimates and Issues (2015) Ministry of Agriculture and Salah El-Ghair. The Egyptian Arabic Republic . in Arabic.

Mohamed; E.M.N., (2001). The Effect of the engineering parameters of the threshers on the seeds quality in different cereal crops, M. Sc. Degree, Agic.Eng. Dep. - Faculty of Agic, Zagazig Univ.

Muna, N.H.; U.S. Muhammed; A.M. El-Okene and M. Isiaka (2016). Perfomance evaluation of a modified I.A.R. multicrop thresher. International Journal of Scientific & Engineering Research. ISSN 2229-5518. 7(11):1107-1116.

Nada; A. A.-H., (1994). Comparative study on locally manufactured, threshing machines for different crops, M. Sc. Degree, Agic. Eng. Dep. – Faculty of Agri, ZagazigUinv.

Pandey, A. and R.M. Stevens (2016). Performance evaluation of high capacity multi crop thresher on ‘gram’ crop. International Journal of Agricultural Engineering, 9(1): 94-101.

Shahbandeh, M. (2021). Wheat-statistics & facts (Mar. 23, 2021) - The Statistics Portal. [online] Statista. Available at: [Accessed 20 April 2021].

Singh, A.K., N. Chandra, R.C. Bharati and S.K. Dimree (2010). Effect of seed size and seeding depth on faba bean (Viciafaba L.) productivity. Environ. Ecology, 28:522-1527.

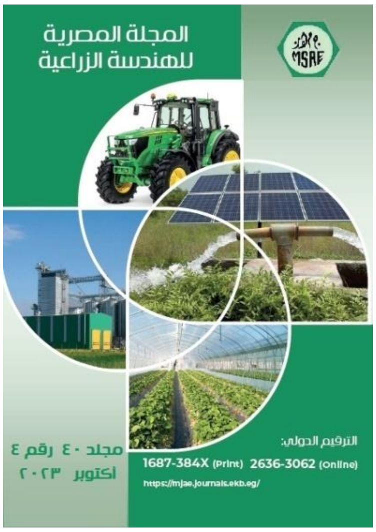
Vejasit, A. and V. M. Salokhe (2004). Studies on machine-crop parameters of an axial flow thresher for threshing soybean. Agriculture Engineering International: the GIGR Journal of Scientific Research and Development. Manuscript PM 04 004.

تطوير آلة دراس صغيرة مناسبة لمحصولي القمح والفول البلدي

نبيل الدسوقي منصور[١] و محمد عبدالجواد أحمد أبو عجيلة[٢]

[١] مدرس الهندسة الزراعية - قسم الموارد الطبيعية والهندسة الزراعية - كلية الزراعة - جامعة دمنهور - مصر.

[٢] باحث اول بمعهد بحوث الهندسة الزراعية – مركز البحوث الزراعية – الدقي - الجيزة - مصر.



الكلمات المفتاحية:

التطوير؛ الفول؛ الدراس.

<u>الملخص العربي</u>

الغرض الرئيسي من هذا البحث هو تطوير وتقييم آلة دراس صغيرة لتناسب المساحات الصغيرة المنتشرة في مصر. تم تطوير آلة الدراس المصنعه بمصنع طنطا للمحركات (إيماجرو)، وتم تقييم أدائها بمحطة البحوث الزراعية إيتاي البارود عام ٢٠٢٠ في تجربتين مستقلتين وفقا للمحصول المدروس. تم تقييم الآلة المطورة على أربعة مستويات لسرعة الاسطوانة (٣٥٠، ٤٠٠، ٤٥٠ و٥٠٠ دورة في الدقيقة مع الفول البلدي - ٦٠٠، ٦٥٠، ٧٠٠ و٧٥٠ دورة في الدقيقة مع القمح) وثلاثة مستويات لمعدل التغذية (٣٦٠، ٤٨٠ و٧٢٠ كجم/ساعة). . استند التقييم إلى المعايير التالية: الإنتاجية، وكفاءة الدراس، وأضرار الدراس، وكفاءة التنظيف، ونسبة البذور المنفوخة (المفقودة) ، ومتطلبات الطاقة، واستهلاك الطاقة والتكاليف. أظهرت النتائج أن كفاءة التنظيف تزداد بزيادة سرعة الأسطوانة تحت كلا المحصولين وجميع معدلات التغذية نتيجة لزيادة سرعة دوران مروحة الهواء لطرد الغبار. كما ارتفعت نسبة البذور المنفوخة (المفقودة) من ١,٠٧% إلى ١,٧٣% بزيادة سرعة الأسطوانة من ٣٥٠ إلى ٥٠٠ دورة في الدقيقة لمحصول الفول البلدي بمعدل تغذية ٧٢٠ كجم/ساعة. وتزداد الطاقة المستهلكة بزيادة سرعة الاسطوانة. كما أشارت النتائج إلى أن انخفاض التكاليف (جنيه/ملجم) مع زيادة معدل التغذية نتيجة زيادة الإنتاجية.