PERFORMANCE EVALUATION OF SOME SUNFLOWER THRESHERS

MAMDOUH A. HELMY[1], IBRAHIM S. YOUSEF[2] AND MOHAMED A. BADAWY[2]

1 Prof. of Ag. E.g., Ag. Mech. Dept., Fac. of Ag., Kafr El-Sheikh, Tanta Univ.

2 Ag. Eng. Res. Inst., Agric. Res. Centre, Dokki , Egypt.

(Manuscript received 4 April, 1999)

Abstract

The objective of the present investigation is to develop, manufacture and evaluate sunflower thresher at Agricultural Research Station, Sakha, Kafr El-Sheikh Governorate. A comparative sunflower threshing test was carried out using the Bamby 049 BBY thresher, a modified French made and [Misr (CRS)] local threshers. Three types of threshing drums, triangular flat-bar (D_1), triangular rasp-bar (D_2) and triangular spike-tooth (D_3), four drum speeds, four concave clearance ratios (C_1 /C_2) and three grain moisture contents were tested to estimate total grain losses, grain damage, threshing efficiency, fuel consumption, power requirement and operating cost.

Results indicated that the spike-tooth drum (D_3) and the clearance ratio of 1.8 gave always better results of the performance evaluation for the modified thresher. Results also indicated that, for optimum performance the thresher's drum speed should be about 9.53 m/s and the grain moisture content ranged from 15.4% to 20.9%.

The modified thresher gave better results of the total grain losses, grain damage and fuel consumption compared with other threshers. While the Misr (CRS) thresher gave the minimum values of threshing power requirements (9.26 k W.h/Mg) for the optimum drum speed of 9.53 m/s and the optimum moisture content of 20.9% compared with other threshers.

The threshing costs per yield unit of the Misr (CRS), modified Bamby 049 BBy threshers and manual method were 10.0,13.04 and 75.0 LE/Mg, respectively.

INTRODUCTION

Sunflower (*Helianthus annus L.*) is one of the important oil crops in the world. It ranks the second after soybeans with respect to oil production (Year book of Agric, F.A.O., 1990). Sunflower crop attracts farmers because of its short-duration season and grows in any season and on any type of soil under diversified conditions. Harvesting threshing and separation of sunflower grains in Egypt are still essentially carried out manually. The traditional method for harvesting, threshing, sepration and getting grain are laborious, time consuming with low production and not economical.

Anwar and Gupta (1990) found that the percentage of mechanical grain damage increased by increasing the cylinder speed and decreased by increasing the concave clearance whereas the threshing grain ratio increased by increasing the cylinder speed and decreased by increasing the concave clearance. Grain damage was in the range of 1.6% to 2.6%. They found that the threshing efficiency was in the range of 90% to 93.1%.

Jadhav and Deshpande (1990) evaluated the performance of pedal-operated hold on type Phule sunflower thresher (consists mainly of three units: threshing unit, cleaning unit and power transmisson unit) for threshing sunflower crop. The threshing and cleaning efficiencies were 100 and 96 to 98%, respectively. They reported that the grain losses in the thresher were within permissible limits and the out put capacity of the machine was low, (about 40 kg seed per hour).

Abdel-Mageed *et al.* (1994) evaluated the performance of the AEnRI Th. locally designed threshing machine in threshing and separating of sunflower seeds. They indicated that for optimum performance, the threshing drum speed and concave clearance should be about 12.82 m/s (350 r.p.m) and 4.5 cm, respectively, at 14% seed moisture content. Minimum values of damage and peeling occurred at the maximum values of clearance and moisture content and minimum value of drum speed. The percent of minimum total loss was 5.8%, and minimum damage ratio was 3.68%.

Morad *et al.* (1997) reported that drum speed of 10.45 m/s (500 r.p.m) and seed moisture content of 13% were recommended for threshing Lupinus crop as it recorded both minimum losses and power.

The main objectives of the present study are:

a- To develop and manufacture a suitable small sunflower thresher.

b- To measure and evaluate the performance of three types of drums [triangular flat-bar (D_1), triangular rasp-bar (D_2), and triangular spike-tooth (D_3)], drum speed, concave clearance ratio (C_1 /C_2) and crop moisture content on the total grain losses, grain damage and threshing efficiency.

c- To carry out a comparative test on the modified sunflower thresher Bamby 049 BBy (French) and [Misr (CRC)] local threshers under different conditions of drum speeds and crop moisture contents.

MATERIALS AND METHODS

The experiments were carried out at the Agricultural Experiment Research Station at Sakha Kafr El-Sheikh Governorate to test the performance of the modified threshing drum developed in sunflower threshing. Table 1 summarizes the technical specification of threshing machines. The modified thresher was manufactured and constructed according to the specifications of the Bamby 049 BBY (French) thresher with some modifications as shown in Fig. 1 while the local (Misr CRS) thresher is shown in Fig.2.

Table 1. Technical specification of threshing machines.

Item	Bamby 049 BBY (French) thresher	Bamby 049 BBY (French) thresher	Misr (CRS) (Local) thresher
Total length (cm)	100	100	224
Total leigth (cm)	130	130	213
Total width (cm)	80	80	190
Length of drum (cm)	45	45	115
Number of bars	3	3	8
Type of drum	Triangular flat bar	(D_1)Triangular flat bar (D_2)Triangular flat bar (D_3)Triangular flat bar	Spike tooth cylinder
Concave clearance ratio (C_1/C_2)	is fixed (1.75)	is varied by a hand wheel	is fixed (1.75)
	By P.T.O. 26.2 kW M.F. 230 tractor		Diesel lengine 20 kW.

Some physical properties and characteristics of sunflower plants variety (Vidok)were measured and summarized in Table2.

Table2. Technical specification of threshing machines.

Head diameter, cm	Head thickness,	Head width, cm	1000 seed mass, g	Seed yield/ head, g	Stem diam., cm	plant height, cm
19.25	3.5	2.3	66.34	169.8	2.55	175

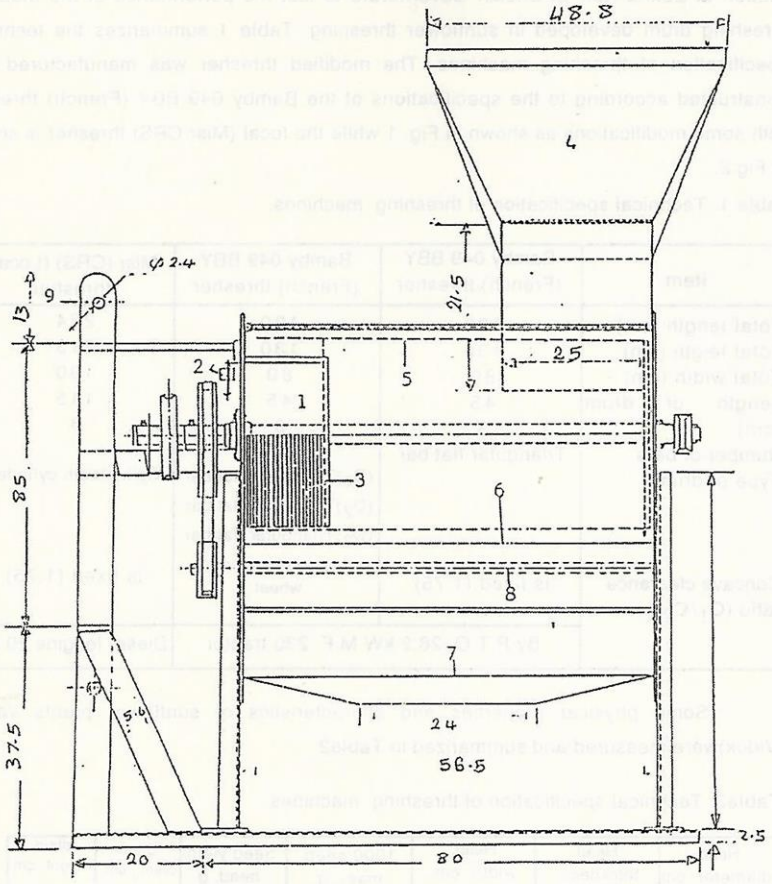
The main parameters were as follows:

1- Drum type: triangular flat-bar (D_1), triangular rasp-bar (D_2) and triangular spike-tooth (D_3), as shown in Fig.3.

2- Peripheral drum speed levels were: 6.59, 8.06, 9.53 and 10.99 m/s.

3- Concave clearance ratio levels were: 1.4,1.8, 2.2 and 2.6.

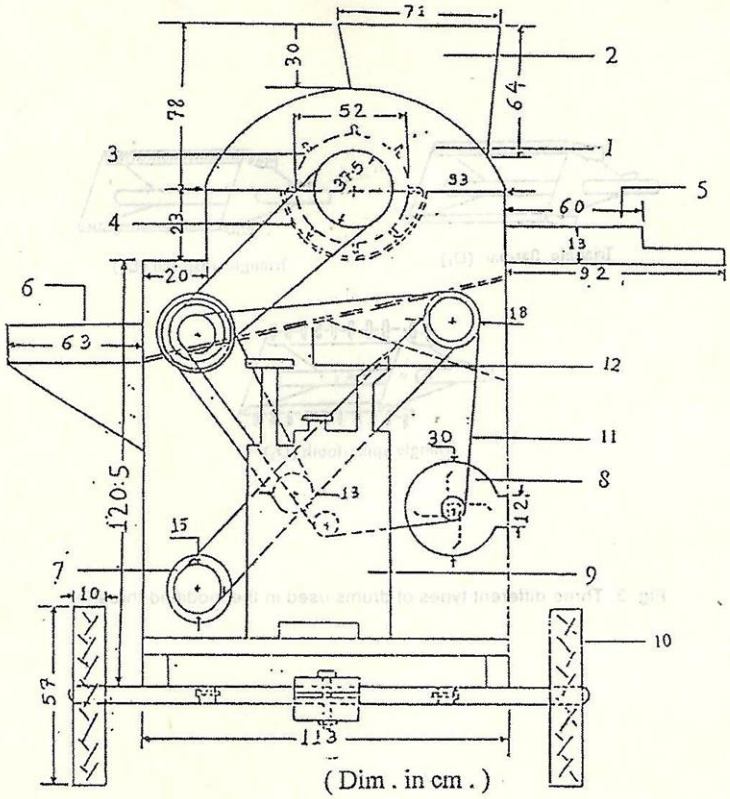
4- Grain moisture content levels were: 15.4, 20.9 and 28%.



1- Waste exite flap
2- Flap conter weight
3- Waste eject sieve
4- Feed opening
5- Drum
6- Concave
7- Sheet iron under thresher
8- Fan shaft
9- Point hiches

(Dim. in cm.)

Fig.1 Side view of the modified thresher



1 - Cover
2 – Feed opening
3 – Threshing cylinder
4 – Concave
5 – Feed board
6 – Upper oscillating screen
7 – Blower
8 – Fan
9 – Engine
10 – Wheel
11 – Belt
12 – Sieve

Fig. 2. Side view of the local machine type (CRS Misr).

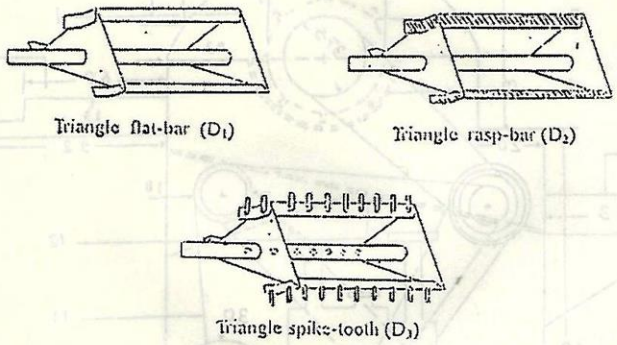


Fig. 3. Three different types of drums used in the modified thresher.

The total grain losses, mechanical grain damage, threshing effeciency and fuel consumption were considered during the experiments. Three samples of 100 grams each were taken from the threshed grain to determine the mechanical grain damage.

Fuel consumption was determined during the threshing operation by measuring the volume of fuel consumed throughout the test treatment using a graduated cylinder of 5 liters volume. Power consumption was approximated by determining fuel consumption for each treatment by using the following formula suggested by Hunt, 1973:

$$BHP = \text{constant} \times Fc \times \rho f \times L.C.V. \times 427 \times \eta_{th} \times \eta_{m}$$

Where:

FC = Fuel consumption, l./h.

ρf= Density of the fuel, Kg/l (for solar fuel = 0.85 kg /l).

L.C.V= Lower calorific value of fuel, KCal/kg, ($\approx 10^4$ KCal/kg for most petrol fuels).

427 = Thermo-mechanical equivalent, kg.m/Kcal.

η_{th} = Thermal efficiency of the engine (considered to be 40%for distel engines).

η_{m} = Mechanical efficiency of the engine (considered to be 80% for diesel engines).

RESULTS AND DISCUSSION

Influence of some operating parameters on the modified thresher performance:

The effect of drum speed, concave clearance ratio and grain moisture content on the total grain losses (Y_1) and grain damage (Y_2) are shown in Fig. 4. It could be observed that the increase of drum speed tends to decrease the total grain losses percentage (Y_1) and increase the grain damage percentage (Y_2) at different moisture contents of grains and different concave clearance ratios.

The minimum mean percentage of the total grain losses (Y_1) obtained were 1.32,2.97 and 5.27% for grain moisture contents of 15.4, 20.9 and 28%, respectively at the maximum level of drum speed of 10.99 m/s and the concave clearance ratio of 1.8.

On the other hand, figure 4 also shows that the concave clearance ratio of 1.8 gave the minimum percentage of the total grain losses (Y_1) compared with the other clearance ratios for all treatments.

The increase of drum speed from 6.59 to 10.99 m/s, at clearance ratio of 1.8 and moisture content of 20.9% caused a decrease in the total grain losses percentage

(Y_1) by 54.02% and an increase in grain damage percentage (Y_2) by 35.8%. This increase in the grain damage is due to the increase of impact forces imparted to the sunflower heads by the drum with the increase of drum speed during threshing process.

The effect of drum speed and type of drum on the total grain losses (Y_1) and grain damage (Y_2) is shown in Fig. 5. It reveals that the increase in drum speed from 6.59 to 10.99 m/s increased the grain damage percentage by 32.74, 35.25 and 40.73% for flat bar (D_1), rasp-bar (D_2), and spike-tooth (D_3), respectively. The optimum drum speed was found to be around 8.53 m/s. It was obtained from the intersection of the curves of the total grain losses and grain damage.

Results show that the spike-tooth drum (D_3) gave the lowest values of the total grain losses (Y_1), and grain damage (Y_2), than that given by the other drums followed by rasp-bar drum (D_2), and flat-ber (D_1), respectively, for all drum speeds.

The effect of concave clearance ratio and type of drum on the total grain losses (Y_1) and grain damage (Y_2), for the modified thresher is shown in Fig. 6. Results show that the increase of clearance ratio from 1.4 to 1.8 decreased the total grains losses by 14.06, 16.05 and 14.48% for types of drums, D_1, D_2 and D_3, respectively. While increasing of clearance ratio from 1.8 to 2.6 increased the total grain losses by 40.81, 43.17 and 35.86% for types of drums D_1, D_2 and D_3, respectively.

On the other hand, the increase of clearance ratio from 1.4 to 2.6 for various types of drum decreased grain damage percentage (Y_2). The optimum clearance ratio lies between 1.8 to 2.2. It was obtained from the intersection of curves of total grain losses and grain damage. The results recommended the use of triangle-spike tooth drum (D_3) which gave the lowest values of the total grain losses and grain damage compared with other drums for all clearance ratios.

Influence of some parameters on the performance of the sunflower threshers:

The effect of drum speed, type of thresher and grain moisture content on the total grain losses (Y_1) and grain damage (Y_2) is shown in Fig. 7. It was found that increasing drum speed, the total grain losses percentage (Y_1) decreased and also the grain demage percentage (Y_2) increased for various grain moisture contents for various types of threshers. The optimum drum speed lies between 8.06 and 10.99 m/s for the modified Bamby 049 BBY (French) and local threshers (Misr CRS).

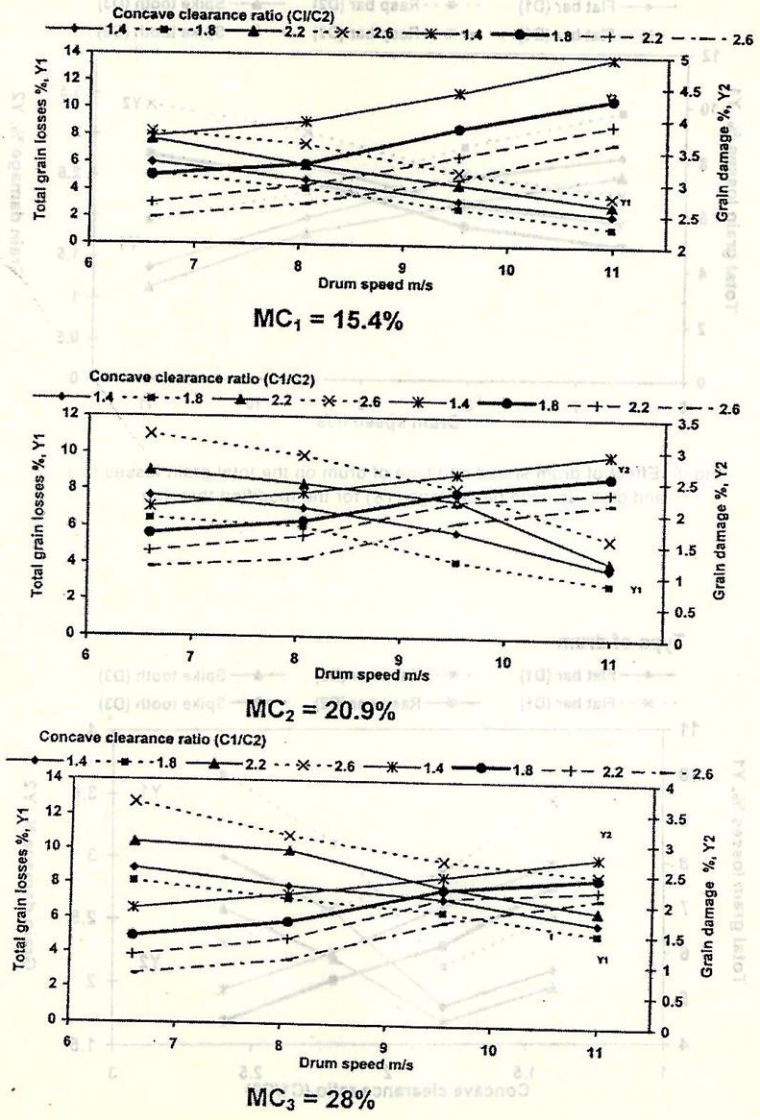


Fig. 4. Effect of drum speed, concave clearance ratio and grain moisture content on the total grain loses (Y1) and grain damage percentage (Y2) for the modified thresher.

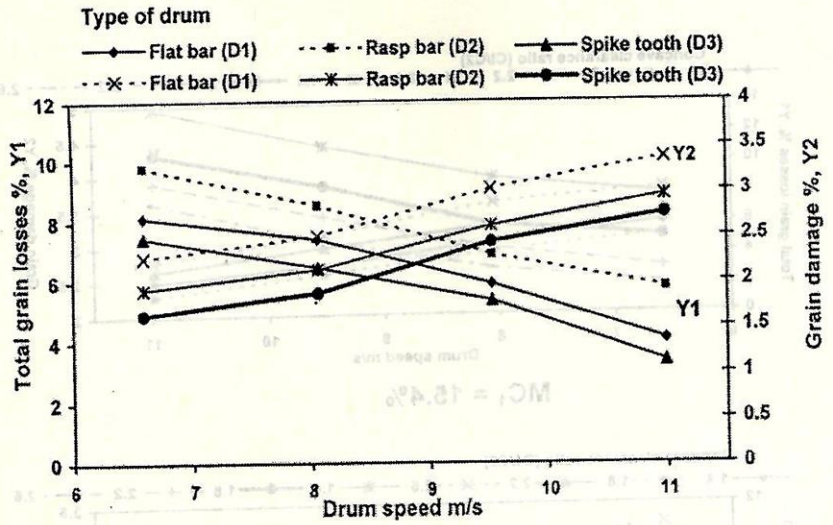


Fig. 5. Effect of drum speed and type of drum on the total grain losses (%) and grain damage percentage (Y_2) for the modified thresher.

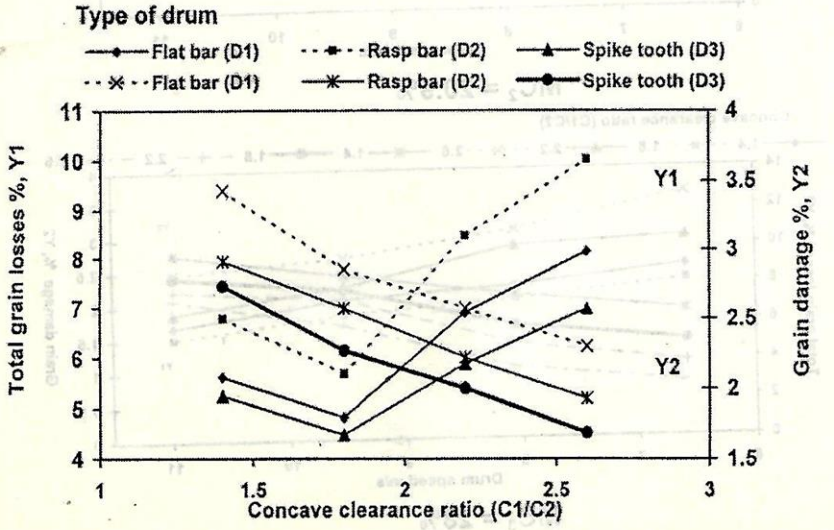


Fig. 6. Effect of concave clearance ratio and type of drum on the total grain losses (%) and grain damage percentage (Y_2) for the modified

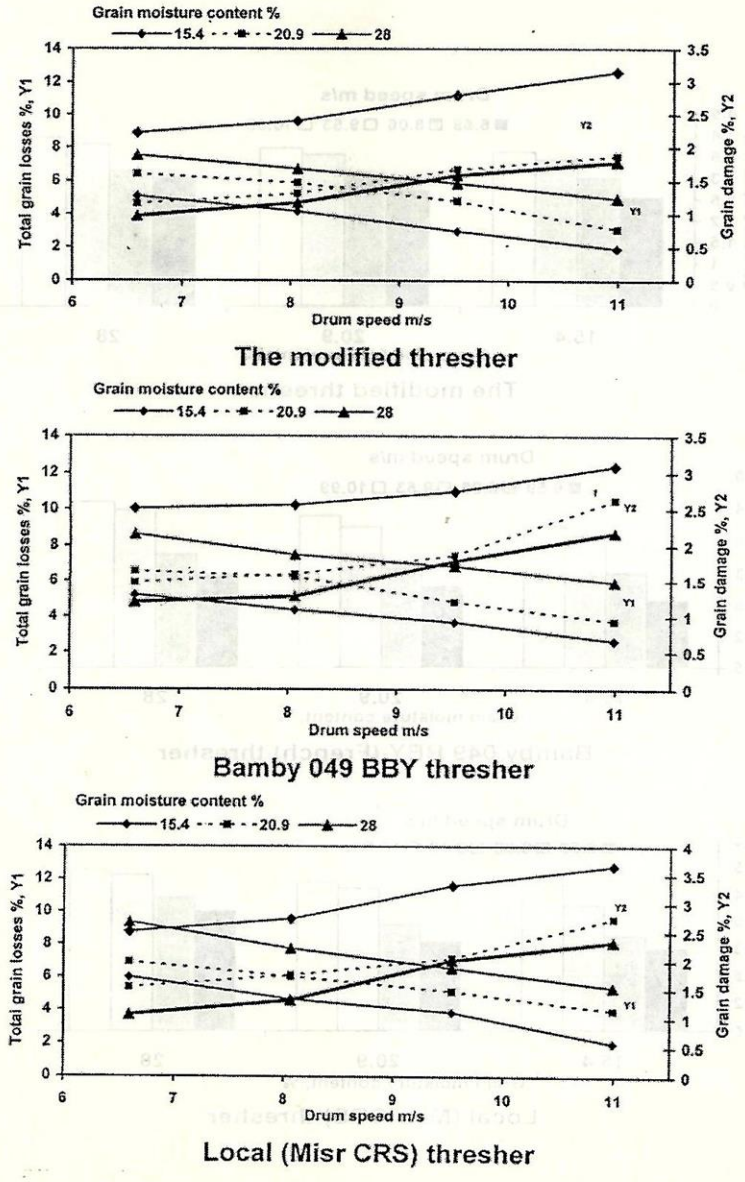


Fig. 7. Effect of drum speed and differnt types of threshers on the total grain losses (%) and grain damage percentage (%) for different grain moisture contents.

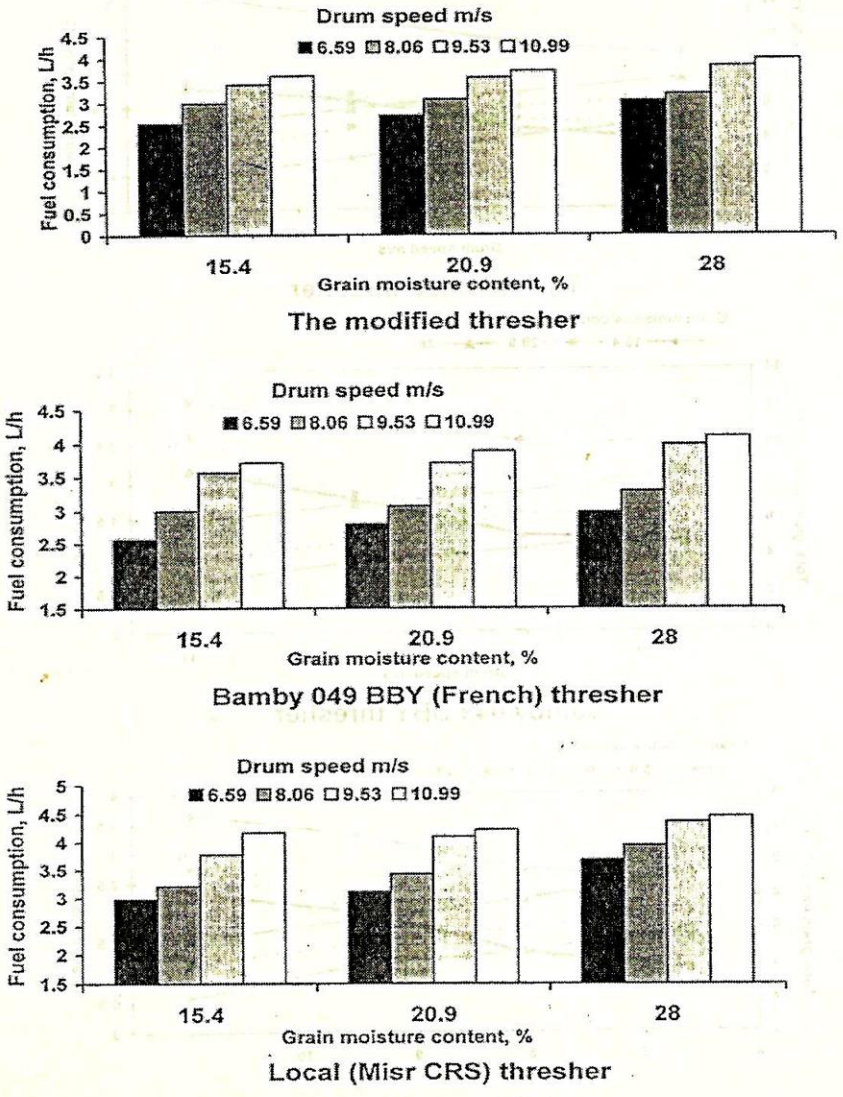


Fig. 8. Effect of different types of threshers and drum speed on fuel consumption (L/h) for different grain moisture contents.

The increase of grain moisture content from 15.4 to 28%, at drum speed 9.53 m/s increased the total grain losses percentage (Y_1) by 49.23,46.06 and 40.85% for the modified, Bamby 049 BBY (French) and local (Misr CRS) threshers, respectively. This may be due to the increase of the grain moisture content and the sunflower heads, thus the grains were not easily threshed and gave more grain losses.

At the same time, the increase of grain moisture content from 15.4 to 28%, at drum speed 9.53 m/s decreased grain damage percentage (Y_2) by 43.57, 34.91 and 39.46% for the modified, Bamby 049 BBY (French), and local (Misr CRS) threshers, respectively. This may be due to the increase of grain moisture content which increase the elasticity of grains. One may say that the optimum grain moisture content falls between 15.4 and 20.9% for various types of threshers and all drum speeds. The ressults show that the maximum threshing efficiencies are 98.08, 98.01 and 97.36% for the modified, Bamby 049 BBY (French) and local (Misr CRS) threshers, respectively. Results also indicated that the modified thresher always gave lower values of the total grain losses percentage and grain damage percentage for various grain moisture contents and all drum speeds than that given by other threshers followed by Bamby 049 BBY (French) and local threshers, respectively.

Fig. 8 shows the effect of different types of threshers, drum speed and various grain moisture contents on the fuel consumption (l/h) during sunflower threshing operation. The fuel consumption increased by increasing drum speed and grain moisture content for various types of threshers.

The increase of drum speed from 6.59 to 10.99 m/s at the grain moisture content 20.9% increased fuel consumption by 26.83,28.09 and 26.13% for the modified Bamby 049 BBY (French) and local (Misr CRS) threshers, respectively.

At the same time, the grain moisture content of 28% always gave the maximum values of fuel consumption compared with other various grain moisture contents followed by 20.9 and 15.4%, respectively, for various types of threshers. While the modified thresher always recorded the minimum values of fuel consumption compared with other threshers followed by Bamby 049 BBY (French) and local (Misr CRS) threshes, respectively. Table 3, shows the effect of various types of threshers and drum speeds on unit power requirement (kW. h/Mg) for various grain moisture contents. The increase of drum speed from 6.59 to 10.99 m/s at the grain moisture content of 20.9% increased threshing unit power requirements by 26.74, 27.89 and 26.13% for the modified, Bamby 049 BBY (French) and local (Misr CRS) threshers, respectively.

The results show that the local thresher (Misr CRS) gave relatively low values of threshing unit power requirements (KWh/Mg) at various moisture contents and all drum speeds compared with other threshers followed by the modified and Bamby 049 BBY (French) threshers. This may be due to the increase of the effective threshing productivity when using the local (Misr CRS) thresher. Table 4 indicated the costs of threshing operations for the modified, Bamby 049 BBY (French),local threshers and manual method.

Table 3. Effect of type of thresher and drum speed on unit power requirements (kWh / Mg) at various moisture contents of grains.

Type of thresher	The modified thresher			Bamby 049 BBY thresher			Local (Misr CRS) thresher		
	M.C.%			M.C.%			M.C.%		
Speed, m/s	15.4	20.9	28.9	15.4	20.9	28.9	15.4	20.9	28.9
6.59	8.09	8.60	9.65	8.16	8.89	9.46	6.74	7.04	8.33
8.06	9.53	9.75	10.10	9.56	9.75	10.44	7.26	7.74	8.89
8.53	10.86	11.31	12.10	11.34	11.79	12.64	8.53	9.26	9.85
10.99	11.47	11.76	12.58	11.81	12.36	13.18	9.42	9.53	10.05

Table 4. Cost analysis for types of threshing

Type of threshing	Total cost, LE/h	Productivity, Mg/h	Unit cost, LE/Mg
The modified thresher	17.06	1.35	13.04
Bamby 049 BBY (French) thresher	22.50	1.35	13.64
Local (Misr CRS) thresher	19.00	1.90	10.00
Manual method	1.5	0.02	75.00

The total costs (1998) based on the list price of the tractor, modified, Bamby 049 BBY (French), and local (Misr CRS) threshers used in the present investigation were 13875, 2250, 5710 and 9200 LE, respectively.

CONCLUSIONS

The present study revealed the following important points:

* The spike-tooth drum (D_3) gave better results of the total grain losses (Y_1) and grain damage (Y_2) than that given by other drums followed by rasp-bar (D_2) and flat-bar (D_1), respectively, for the modified thresher.

* The optimum clearance ratio falls between 1.8 to 2.2 to obtain a reasonable percent

of the total grain losses and grain damage for the modified thresher.

*The total grain losses percentage and grain damage percentage were highly affected by the drum speed. The optimum drum speed lies between 8.06 and 1.99 m/s for the modified, Bamby 049 BBY (French) and local (Misr CRS) threshers.

*The best result of the total grain losses and grain damage occurred at the optimum moisture content range of 15.4 to 20.9%.

* The modified thresher always gave the lowest values of the total grain losses, grain damage and fuel consumption compared with other threshers followed by Bamby 049 BBY (French) and local then (Misr CRS) threshers, respectively, for all treatments.

* The local (Misr CRS) thresher recorded the minimum values of threshing unit power requirements (kW.h/Mg) and the threshing cost per unit production (LE/Mg) compared with other threshers followed by the modified and Bamby 049 BBy (French) threshers. This may be due to the increase of the threshing productivity with the local (Misr CRS) thresher.

REFERENCES

1. Abdel-Mageed, H.N.; M.A. El-Saadany and A.S. Hamam (1994). The optimum working conditions of a locally designed machine in threshings sunflower crop. J. Agric. Sci., Mansoura Univ., 19(10):3421-3432.

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

3. Hunt, D. (1973). Farm power and machinery management. Handbook, Iowa State University, Press, AMES, 2nd ed.

4. Jadhav, RV. and J.S. Deshpande (1990). Development and performance evolution of pedal-operated sunflower thresher. AMA., 21(3): 29-32.

5. Morad, M.M.; M.A. Aranaout and A. Mohamed (1997). Mechanization of Lupinus crop-production under Egyptian conditions. Misr. J.Ag. Eng., 14(2): 181-192.

6. Yearbook of Agriculture (1990) F.A.O.

تقييم أداء بعض آلات دراس عباد الشمس

ممدوح عباس حلمى[1] ، إبراهيم صلاح الدين محمد يوسف[2]
محمد الشحات عبد العزيز بدوى[2]

١ *استاذ الهندسة الزراعية كلية الزراعة بكفر الشيخ - جامعة طنطا*
٢ *باحث بمعهد بحوث الهندسة الزراعية - محطة البحوث الزراعية بسخا.*

الغرض من هذا البحث هو دراسة وتقييم أداء آلة دراس عباد الشمس معدله صغيرة الحجم تناسب المزارع الصغير ومقارنتها بآلتين أحدهما فرنسية الصنع والثانية محلية كبيرة الحجم وتم تصنيع هذه الآلة بنفس مواصفات وأبعاد آلة الدراس الفرنسية الصنع مع إضافة بعض التعديلات عليها مثل جعل صدر الدراس متحرك حتى يمكن ضبطة بسهولة حسب الخلوص المطلوب بين صدر ودرفيل الدراس. كذلك تقييم ثلاثة أنواع من درافيل الدراس المصنعه محليا بهذه الآلة فى عملية دراس محصول عباد الشمس صنف فودك.

وقد تم قياس الأداء لهذه الآلات باستخدام أربع سرعات لدرفيل الدراس وثلاثة مستويات من المحتوى الرطوبى للحبوب وإيجاد نسبة الفقد الكلى فى الحبوب ونسبة الكسر وكفاءة الدراس واستهلاك الوقود والطاقة المستهلكة مع حسب التكاليف الكلية.

وقد أوضحت النتائج أنه فى الآلة المعدلة المصنعه محليا كان أفضل درفيل دراس هو Spike tooth cylinder (D_3) وكانت أفضل نسبة خلوص بين الصدر والدرفيل هى١,٨ حيث أعطيا أقل النتائج فى نسبة الفقد و الكسر بالحبوب كما أوضحت إلنتائج آن أنسب ظروف تشغيل للثلاث آلات هى سرعة درفيل تتروح فيما بين ٨,٠٦ - ١٠,٩٩ /ث ومحتوى رطوبى بالحبوب يتراوح فيما بين ١٥,٤ - ٢٠,٩ ٪ (أساس رطب) حيث أعطوا نسب متوازية من نسبة الفقد الكلى والكسر فى الحبوب وكذلك استهلاك الوقود (لتر/ساعة).

هذا وقد بلغت إنتاجية كل من الآلة المعدلة والمصنعه محليا والآلة الفرنسية (Bamby 049 BBY) ١,٣٥ ميجا جرام/ ساعة بينما بلغت إنتاجيه الآلة المحلية الكبيرة (Misr CRS) ١,٩ ميجاجرام ساعة كما أوضحت النتائج أن الآلة المعدلة المصنعه محليا كانت أفضل الآلات يليها الفرنسية يليها المحلية (Misr CRS) وذلك من حيث نسبة الفقد الكلى ونسبة الكسر فى الحبوب واستهلاك الوقود وكفاءة الدراس.

بينما أعطت الآلة المحلية الكبيرة (Misr CRS) أقل قيم للطاقة المستهلكة وأقل تكلفة للميجاجرام مقارنة بالآلتين الآخريتين ويعزى ذلك لزيادة إنتاجية هذه الآلة وهو (١,٩ ميجاجرام/ساعة) حيث كانت التكلفة الكلية هى ١٠,٠٠، ١٣,٠٤ ، ١٦,٦٤ ، ٧٥,٠٠ جنية /ميجاجرام لكل من الآلة المحلية الكبيرة (Misr CRS) ثم الآلة المعدلة المصنعه محليا ثم الآلة الفرنسية (Bamby 049 BBY) ثم الطريقة اليدوية على الترتيب .