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DEVELOPMENT OF THRESHING SYSTEM IN COMBINE HARVESTER FOR IMPROVING OF ITS PERFORMANCE EFFICIENCY IN RICE THRESHING

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ABSTRACT

The combine (Class Crop Tiger) which was used in the present study is middle size (2.10 m cutting width). The axial flow drum was used in this combine. Separation wings were parallel with its axis. So, some improvements could be added to the axial-flow threshing/separating drum to improve the straw flow to reduce blockage, loss and to improve field efficiency and grain yield. So, improving the performance of combine machines during the harvesting operation of cereal crops is important to minimize both grain losses and operational costs.

The main experiments were carried out at Ahmed Ramie Farm, Etai Al Barod, El-Behera Governorate, in order to compare four different types of threshing and separation drums of combine. The experiments were conducted in productive rice crop, variety (Giza 171) in an area of about 4.10 feddans. Specifications of threshing and separation drum before and after development:

1- *Design and fabricate three serrated agitator ledge (15, 10 and 7 teeth), so that the passing crop and separation will be easy.*
2- *The length of threshing and separation is 180 cm, it consists three parts, the first part of the threshing section length 57.5 cm, the second part of the separation section length 90.5 cm, it change the separation section length to 110.5 cm to increase the grain separation efficiency and the third part of the straw exit section length to 22 cm.*
3- *The thickness of the separation vane to be 5nm instead of 3.5 min.*
4- *Using steel 60 to overcome the wear of vanes during the separation operation.*

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Using three levels of cylinder speed as 500, 630 and 803 rpm (17.0, 21.4 and 27.3 m/s, adjusting the cylinder-concave clearance by using three levels of clearance namely 12.5/5.5, 13/6 and 16/7 n, and using two levels of feeding rate 2000 and 3000 kg/h. The results showed that:

1- *The total grain losses decreased by decreasing both of the feed, rate, operating forward speed, threshing drum speed and the cylinder-concave clearance.*
2- *The threshing efficiency increased by decreasing the feed rate and operating forward speed, and it decreased by decreasing threshing drum speed, increasing the cylinder-concave clearance.*
3- *The grain quality increased by decreasing the feed rate, operating forward speed and threshing drum speed, and it decreased by decreasing the cylinder-concave clearance.*
4- *The cleaning efficiency increased by decreasing the feed rate, operating forward speed and threshing drum speed, and it decreased by increasing the cylinder-concave clearance.*
5- *The highest values of the actual field capacity at the feed rate 200kg/h/operating forward speed of 1.22 km/h/grain moisture content 21%, threshing drum speed of 500 rpm (17 m/s) and the cylinder-concave clearance (C_1) of 12.5/5.5mm, was found to be as the developed rotor 7 teeth (0.489 fed/h), the develop rotor 10 teeth (0.473 fed./h), the developed rotor 15 teeth (0.460 fed./h) and the original rotor 15 teeth (0.42g fed./h).*
6- *The least values of the required energy at the feed rate of 2000 kg/h, operating forward speed of 1.22 km/h/grain moisture content of 21%, threshing drum speed of 500 rpm (17 m/s) and the cylinder-cancer clearance (C_1) of 12.5/5.5 mm, was found to be as the developed rotor 7 teeth (30.186 kw.h/fed.), the developed rotor 10 teeth (34.600 kw.h/fed.), the developed rotor 15 teeth (41.159 kw.h/fed.) and the original rotor 15 teeth (51.613 kw.h/fed.).*
7- *The least values of the operating costs at the feed rate of 2000 kg/h, operating forward speed of 1.22 km/h/grain moisture content of 21%, threshing drum speed of 500 rpm (17 m/s) and the cylinder. Concave clearance (c_1) of 12.5/5.5 mm, was found to be as the developed rotor 7 teeth (223.50 LE/fed.), the developed rotor 10 teeth (240.50*

LE/fed.), the developed rotor 15 teeth (270.25 LE/Fed.) and the original rotor 15 teeth (314.75 LE/fed.).

8- *The better results were reached under operating conditions was found to be as threshing drum speed of 500 rpm, feed rate of 2000 kg/h, operating forward speed of 1.22 km/h, cylinder-concave clearance of C, (12.5/5.5 mm) at grain moisture content of 21% was found to be as the developed rotor (7 teeth), whereas the total grain losses of 1.68%, required energy of 30.186 kw.h/fed., operating costs of 223.50 LE, fed., threshing efficiency of 99.34%, separation efficiency of 99.27% and, cleaning efficiency of 99.71%.*

INTRODUCTION

Recently, strengthen support for take advantages of the modern bio-technology would be of paramount importance for Egypt to attain self-sufficiency of rice crop. Rice crop is one of the major field crops in Egypt. It is grown in 1.3 million feddan of the total agricultural area. During the five years before 2000 paddy production averaged 4.6 million tons and the national average yield was 3.6 tons/fed., Ministry of Agriculture (2000).

Mechanical harvesting is one of the most important operations in rice crop production. Government encourages the farmers to use new technology to overcome the high cost of traditional harvesting and labour shortage especially in the harvesting time. Therefore it is necessary to mechanize rice harvesting to reduce losses and costs. Combine harvester should be used for its minimum production losses and low cost.

Kepner *et al*., (1982) found that seed losses from a combine can occur in connection with any of the four basic operations. Theses losses are often indentified as header, cylinder, walker and shoe losses. Gathering losses in direct combining include heads, pods or ears and free seed, lost during the cutting and conveying operations. They stated that threshing effectiveness is related to: cylinder speed, cylinder concave clearance, number of rows concave teeth used with spike tooth cylinder type of crop, the condition of crop in terms of moisture content, maturity etc., and the rate at which the material is fed into the madnine.

Sheruddin *et al.*, (1991) found that with decreasing moisture content of grain, increased grain losses. The lowest grain losses were observed at a range of 4-15 (w.b.) grain losses increased with dalay in harvesting and at different timings of harvest.

Abd El-Mawla (1996) stated that combine harvesters have been developed to increase the combine capacity in combining certain crops, to overcome hard conditions of the crops, to facilitate easier maintenance and to increase the overall efficiency of the combine.

Ichikawa and Sugiyama (1986) developed a new combine harvester equipped with screw type threshing and separating mechanisms. They found that the harvesting performance of the new combine showed the total grain loss rate was lower than 3% and the percentage of damaged grains was less than 1% for rice, soybean, wheat and barley crops.

Kamel (1999) evaluated the total rice grain harvesting losses utilizing two different combine harvesters (CA-385, 1.4 m, hold. In and CA-760, 2.06 m, through-in) with three harvesting speeds of 0.3, 0.5 and 0.8 m/s for both combines and three rice varieties of (Giza 178, Sakha 101 and Sakha 102). The results indicated that the total losses of grain was 3.3, 2.4 and 2.8% for rice varieties Giza 178, Sakha 101 and Sakha 102 respectively for combine harvester CA-385 in comparison with 3.9, 3.1 and 3.4% for combine harvester CA-760.

El-Awady *et al*., (2000) evaluate the performance of Barmel rice-thresher. They concluded that the best performance of Barmel rice thresher was at 550 rpm (29.64 m/s) which gave minimum criterion cost of 4.13 LE/ton, acceptable cleaning efficiency of 94.61% and threshing capacity of 2.68 ton/h.

Morad and Fouda (2003) develop long axial flow rice thresher (Barmel thresher) to be suitable for threshing rice crop with high efficiency and low power consumption. Increasing input capacity from 1.8 to 2.5 ton/h, at constant drum speed of 24.64 m/s, increasing threshing power by 14.12 and 11.69% for threshers before and after development, resp. Also, increasing drum speed from 21.51 to 26.70 m/s, at constant input capacity of 2.25 ton/h, increased threshing power by 14.12 and 11.69% for threshers before and after development, resp.

El-Hadad (2000) stated that the threshing efficiency increased with increasing drum speed and decreasing feed rate. The maximum threshing efficiency was 99.76% at drum speed of 21.25 m/s (1400 rpm), and feed rate of 15 kg/min. (900 kg/h). The maximum amount of visible grain damage was 0.90% under these conditions.

Simonyan and Oni (2001) reported that there is an increase in threshing efficiency and extractor efficiency with decrease by the cylinder speed.

El-Nakib *et al*. (2003) stated that an evaluation was carried out using Kubota combine (Pro 481) as a mechanical harvester of rice (Sakha 102). The grain moisture content was varied at (23.8, 19.3 and 16.5%). Forward speed were (2.3, 2.7, 4.5 and 5.14 km/h) and air fan velocities (22.2, 25.3 and 27.6). The were previous factors studied and evaluated o combine losses (as header, threshing, separating and shoe losses). The results show that:

- Header, threshing, separating and shoe losses increase with increasing of the forward speed and the decrease of grain moisture content.
- The total losses (TL), forward speed (S) and grain moisture content (GMC) were formulated by the formula "TL= (10.5 $GMC^{-0.79}$)$S^{0.75}$, under previously mentioned condition.
- The optimum operating harvesting rice crop was at combine forward speed 4.5 km/h and grain moisture content of 16.5%.
- The optimum air fan velocity during operating rice was 6.17 m/s. The aim of this research is to develop the axial-flow threshing and separating drum to improve the straw flow to reduce the problems of the blockage, losses and top improve field capacity and grain yield. Consequently, minimizing both grain losses and operational costs.

MATERIAL AND METHODS:

From the interview with some operators of the combine machine, they noticed that many difficulties to achieve smooth operation in fields specifically for the wheat and rice crops. The most frequent breakdowns occurred because of crop and straw blockage inside the threshing separation housing. The drum blockage occurred frequently causing low machine productivity of field efficiency, low through put and high of total grain losses, in this study it proposed the vane rotors with an inclined angle in the direction of rotation. So, improvements were added to the axial-flow threshing/separating drum to increase the straw flow and discharge through out to reduce blockage and overcome the complain of the increasing of the total grain losses and to improve machine productivity and field efficiency.

The main experiments were carried out at Ahmed Ramie Farm, Etai Al Barod, El-Behera Governorate,t o compare different types of threshing and separation drums of combine class crop Tiger, Table (1).

The experiments were conducted in a productive rice crop grown with the variety (Giza 171) in an area of about 4.10 feddans.

Table (1): Specifications of Class crop tiger combine.

No.	Feature	Class crop tiger combine
1	Source of manufacture	Germany
2	Model	Crop tiger
3	Type	Standard
4	Engine	4-cylinder diesel engine (Isuzu)
5	Engine power:	Powerful 43 kW (58 hp) at 3000 r.p.m.
6	Drive	Hydrostatic 0-10 km/h.
7	Undercarriage	Rubber wheel type
8	Dimensions: - Length with cutter bar - Width with cutter bar - high (without sunroof) - net weight	 560 cm 255 cm 298 cm 3600 kg
9	Cutter bar:	2.1 m cutting width. 5-section reel with 2 stage drives for 18 and 31 rpm. Hydraulic cutting height control.
10	Threshing system: - length rotor - diameter rotor - 4 speeds,	Threshing and separating 1800 mm. 450 mm. 500, 803, 1013 and 1280 rpm.
11	Threshing section width: Separating section width	575 mm. 1225 mm
12	Grain tank	1200 liter capacity Top filling system Swinging unloading auger

The basic developments of the rotor ledge are as follows:

1- Design and fabricate three serrated agitator ledge (15, 10, 7 teeth), so that the passing crop and separation will easy. The designed serrated agitator ledges are shown in Fig. (1), with an inclined angle in the direction of rotation.
2- The length of separation to be 110.5 cm instead of 90.5 cm increases the grain separation efficiency.
3- The thickness of the separation vane to be 5 mm instead of 3.5 mm and (using steel 60) to, overcome the wear of vanes during the separation operation.
4- Installation a set of louvers inside the rotor's cover, with change the angle of the louvers to be 75° rather than 90° along the axis of the threshing and separation cylinder.
5- Adjusting the cylinder concave clearance by using three levels of clearance namely 12.5/5., 13/6 and 16/7 mm for the rice, Fig. (2)>
6- Sing two levels of feeding rate: 2000 and 3000 kg/h at forward speeds 1.22 and 1.91 km/h.
7- Three levels of cylinder speed as 11.77 (500), 14.80 (630) and 18.91 (803) m/s (r.p.m.).
8- The developed parts wre made mainly from local steel sheet. The following steps of manufacture processing for serrated agitator ledge were carried out:

   1- Cutting up; 2- Rasping; 3- Rolling process; 4- Heat treatment; 5- Milling. To meet high or repeated loads (impact loads).

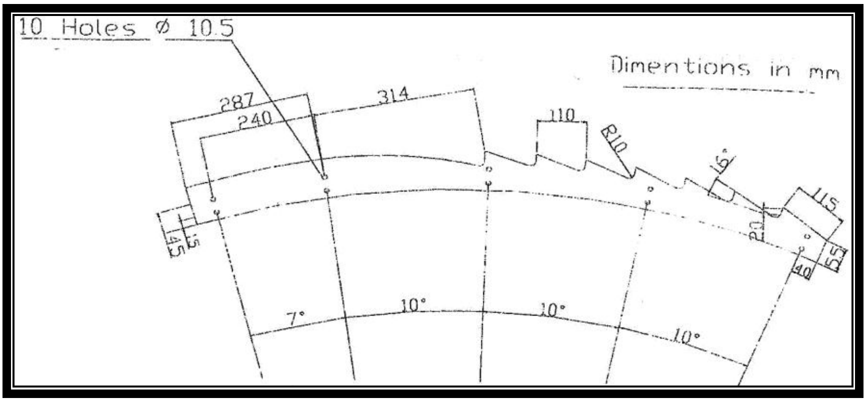
1- Threshing drums:

1.1. The original drum:

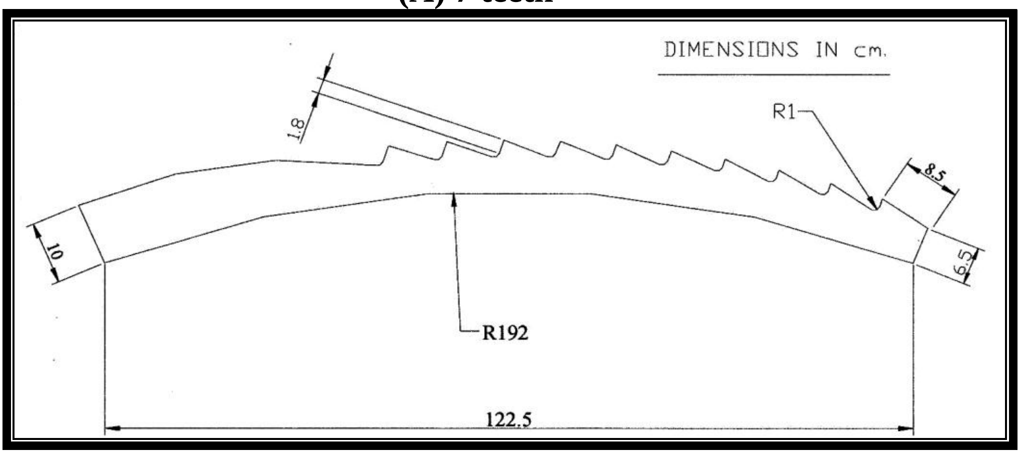
Fig. (3) show the original drum which is 180 cm in length with 45 cm diameter used rice crop. The rotor shaft passes through the center of the cylindrical rotor where a circular steel sheet is welded to close each of the rotor ends. Bases are welded on the rotor surface to fix the threshing elements and separation parts in their positions respectively.

a) Threshing part:

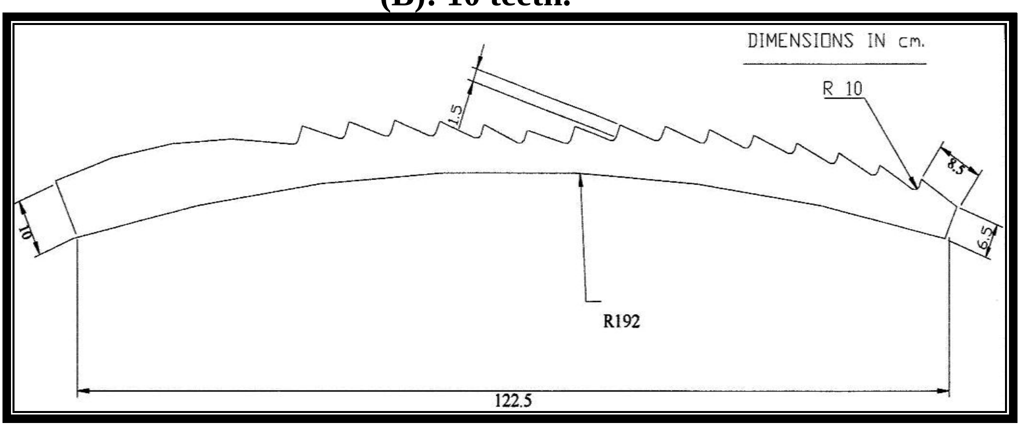
The threshing section length is 57.5cm and consists of 8 bars spike0tooth fixed on the drum surface in rice crop. The concave, is formed from rectangular (Oval halls) bars parallel to the cylinder axis. The clearance between the concave bars and the corrugated cylinder bars is adjustable. No changes were done to the section assigned for threshing.



(A) 7 teeth



(B): 10 teeth.



(C): 15 teeth

Fig. (1): Design of the serrated agitator ledges for the section of separation

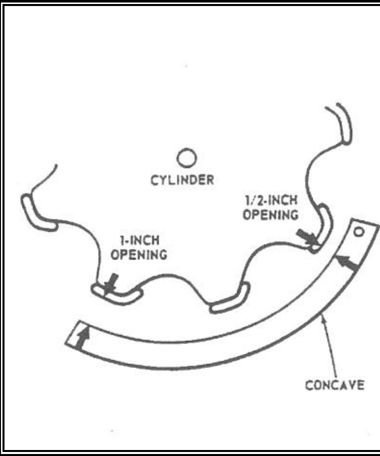


Chart 1: Typical front and rear spacing Proportions for wheat crop.

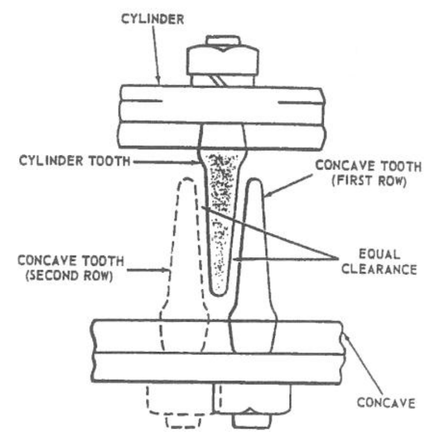
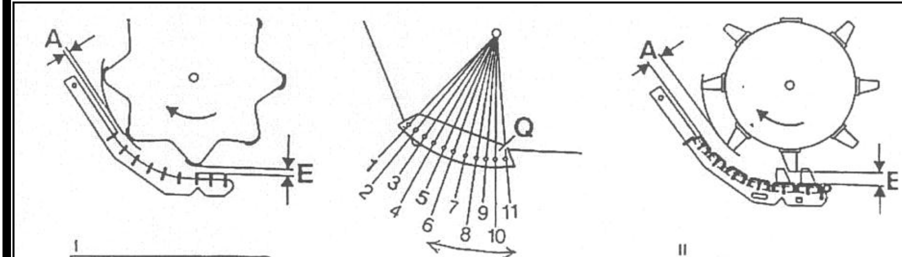


Chart II: Spike cylinder teeth pass Concave teeth fro rice crop.



I

H	E	A
1	9	4
2	9,5	4,5
3	10	5
4	11,5	5,5
5	13	6
6	15	7
7	18	8
8	22	10
9	25	12
10	28	14
11	31	16

II

H	E	A
1	11	4
2	11,5	4,5
3	12	5
4	12,5	5,5
5	13	6
6	16	7
7	20	8
8	25	10
9	30	12
10	33	14
11	38	16

Fig. (2): Drum concave-clearance:

Chart I: Concave settings for threshing rice, by spike tooth drum and spike concave

Chart II: Concave settings for threshing wheat, by rasp bar.

H – Levering. Hole in quadrant,

E = Entrance of concave (mm).

A = Exit of concave (mm);

Q = The front and rear of the concave are simultaneously adjusted.

b) Separation part:

The serrated agitator ledge (vane rotors) assigned for separation section with length 90.5 mm is fixed on the body of rotor. It has two ends, the height of 1st end is 10 cm at the straw rejecting part and 7.5 cm at the other end. Four serrated agitator bars which are fixed to the above mentioned bases parallel to the drum axial. The thickness of the separation vane is 3.5 mm. The number of teeth on the serrated agitator bar is 15 teeth.

c) Straw exit section:

It is the rear end of the separation agitator ledge section, the height 10 cm, length 32cm and it is not serrated to work as a discharge edge in front of straw exit section outer. The straw is discharged on the left-hand side into the ground.

d) Louvers inside the threshing drum:

Installation of a set of louvers inside the threshing rotor's cover, such that could be set at 90° degrees to the drum axis of the threshing the separation cylinder.

1.2. The developed drum:

Fig. (4) show the developed vane rotors which is 122.5 cm length with 45 cm diameter.

a) Separation section:

The serrated agitator ledge (vane rotors) assigned for separation section with length 1005 mm is fixed on the body of rotor. It has two ends, the height of 1st end is 10 cm at the straw rejecting part and 7.5 cm at the other end. Four serrated agitator bars which are fixed to inclined angle in the direction of rotation to the drum axial. The thickness of the separation wing is 5 mm. The number of teeth on the serrated agitator bar is 15, 10 and 7 teeth of four serrated agitator bars (vane rotors) using.

b) Straw rejected outlet:

This part works as beater with four vanes. Each modified with dimensions of the rear of the separation agitator section height 10 cm and length 22 cm is not serrated to work as a discharge edge in front of straw discharge outlet. The kernels separated here fall also into the front and rear conveying auger through. The straw is discharged on the left-hand side into the ground or is delivered via conveyor belt the rear of the combine.

c) Louvers inside the threshing drum:

The direction of louvers with horizontal axes 75° degrees and vertical axes 15° degrees tot eh drum axis of the threshing and separation cylinder, with rice crop. Installation of a set f louvers inside the threshing drum's cover. Table (2) show a comparison between the original and developed drums.

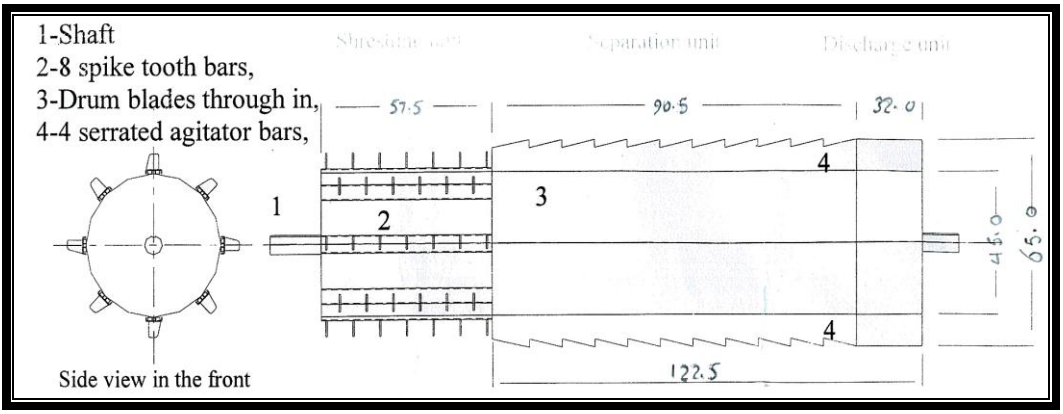


Fig. (3): The original drum with 180 cm length and 45 cm diameter used or the rice crop.

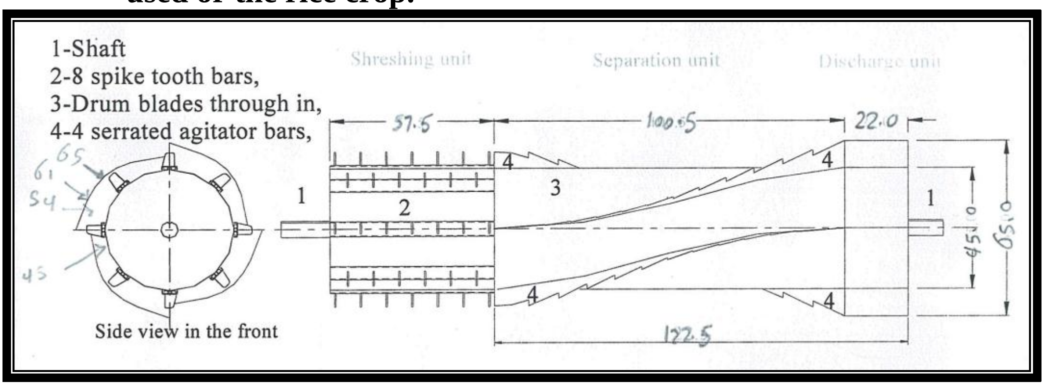
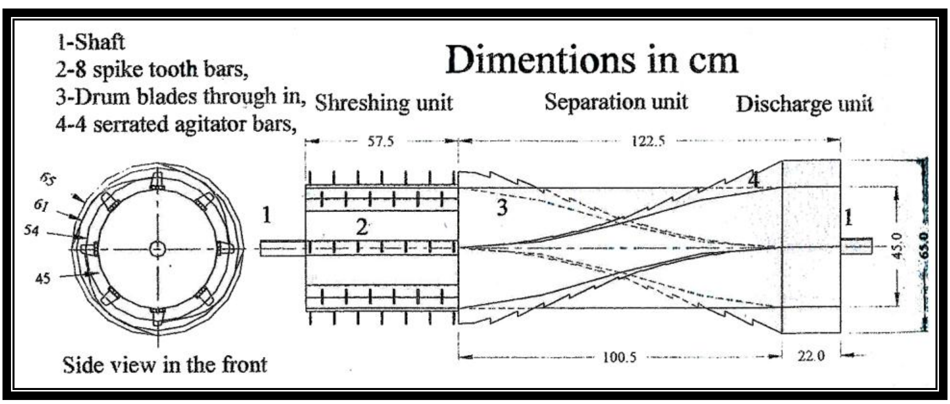


Fig. (4): The developed serrated agitator ledge (vane rotors) for rice crop.



(B) Front view

Fig. (5): Developed drum shows different diameter and pathway the vane rotors on the cylinder.

The vane rotors preparation:

A) Vane rotors shape:

Vane rotors shape shown in Fig. (5).

Table (2): Technical data of two different drum (developed drum and original drum) for rice crop.

Items	Original drums	Developed drums
Diameter the drum, cm	180	180
Separating section: length, cm	90.5	110.5
Height the serrated agitator bare, mm	10	8
Number of tip on the serrated agitator bare	15	15,10 and 7
Length of the separated agitator bars, cm	90	110
The tip depth of the separated agitator bars, cm	2.5	1.5
Thickness of the separated agitator bars, mm	3	5
Weight of the drum, kg	2	2.5

2. Performance parameters for threshing cylinder:

The following criteria by FAO (1994) were used to evaluate the performance of the threshing machine on threshing efficiency, grain quality and cleaning efficiency:

Unthreshed grain:

$$\text{Unthreshed grain \%} = \frac{\text{Weight of unthreshed grain}}{\text{Weight of total grain}} \times 100 \qquad \text{……..(1)}$$

Threshing efficiency:

Threshing efficiency % = (100 – unthreshed grain %) ………………(2)

Grain damage:

$$\text{Grain damage \%} = \frac{\text{Weight of grain damage}}{\text{Weight of total grain}} \times 100 \qquad \text{……..(3)}$$

Grain quality:

Grain quality % = [100 – grain damage (visible) %] …………(4)

Cleaning losses:

$$\text{Cleaning losses \%} \quad \frac{\text{Weight of cleaning losses}}{\text{Weight of total grain}} \quad \text{x 100……..(5)}$$

Cleaning efficiency:

Cleaning efficiency % = [100 – cleaning losses %]……………(6)

Total losses:

Total losses % = [Grain damage + Unthreshed grain + Cleaning losses]….. (7)

Theoretical field capacity:

The theoretical field capacity (TFC) was calculated by using the following formula (Kepner *et al*., 1982).

$$TFC = \frac{W \times S}{4.2} \quad \text{….. fed./h…….(8)}$$

Where:

W is the working width of a machine, m;

S-average machine forward speed, km/h.

Actual field capacity:

The actual field capacity (AFC) was calculated by using the following formula (Kepner *et al*. 1982).

$$AFC = \frac{60}{TU + TL} \quad \text{….. fed./h…….(9)}$$

Where:

TU is the utilization time per feddan in minutes;

TL – Summation of lost time per feddan in minutes.

Field of efficiency:

The field efficiency (η_f) was calculated by using the following formula (Kepner *et al*. 1982).

$$\eta_f = \frac{AFC}{TFC} \quad \text{X 100,….} \quad \text{\% ....(10)}$$

Power required:

To estimate the engine power during harvesting process, the decrease in fuel level was accurately measured immediately after each treatment. The following formula was used to estimate the power required (PR), Hunt 1983.

$$PR = FC \times \frac{1}{3600} \; Pf \times L.C.V. \times 427 \times \eta_{th} \times \eta_m \times \frac{1}{75} \times 0.746$$

= 3.209, ……….. kw…………(11)

where:

FC is the fuel consumption, L/h.

Pf. Density of the fuel, kg/L (for Diesel = 0.85).

L.C.V. = Lower calorific value of fuel, Kcal/Kg (average of solar=10000 (Cal/Kg);

427 – constant (thermo-mechanical equivalent), (kg.m/Kcal);

η_m = Mechanical efficiency for the engine (considered to be about 80% for diesel engine);

0.746- coefficient for changing from hp to kw;

Energy requirement:

The energy requirement was calculated by using the following formula:

$$\text{Energy requirements} \quad \frac{\text{PR (kW)}}{\text{AFC (fed./h)}} \quad \text{kW.h/fed} \qquad ....(12)$$

Cost analysis:

Machine cost was determined using the following equation (Awady *et al*. 1982):

$$C = \frac{p}{ht}\left(\frac{1}{a} + \frac{1}{2} + t + r\right) + (0.9\, w.s.f.) + \frac{m}{144} \text{..........LE/h} \qquad (13)$$

Where:

c is the hourly cost, LE/h;

p - Price of machine, LE;

h - yearly working hours, h/year;

a- life expectancy of the machine, h

i- interest rate/year;

t- taxes, over heads ratio;

r – repairs and maintenance ratio;

0.9 – factor accounting for lubrications;

w – engine power, hp

s – specific fuel consumption, L/hp.h;

f- fuel price, LE/L;

m – monthly average wage, LE;

144 – reasonable estimation of monthly working hours.

The operational cost was determined using the following equation:

$$\text{Operating cost} = \frac{\text{Machine cost (LE/h)}}{\text{Actual field capacity (fed./h)}} ,\ldots\ldots\ \text{LE/fed.} \quad (14)$$

RESULTS AND DISCUSSION

The main objective of present study is to develop the axial-flow threshing, separation drum to improve the straw flow to reduce the problems of blockage, losses and to improve field capacity and grain yield. Consequently, minimizing both grain losses and operational costs.

The experiments were carried out to compare four different threshing and separation drums: original vane rotors (15 teeth), developed vane rotors (15 teeth), developed vane rotors (10 teeth) and developed vane rotors (7 teeth) during harvesting rice crop variety (Giza 171).

The cylinder-concave clearance was adjusted to obtain three clearances for rice crop. The cylinder-concave clearances for the four threshing and separation drums of the combine (class crop tiger) were C_1 (12.5/5.5), C_2 (13/6) and C_3 (16/7) mm.

1. Effect of some operating parameters on grain losses:

The threshing losses are affected directly by different operating parameters such as threshing drum speed, feed rate, operating forward speed, grain moisture content…..etc.

a- Unthreshed grain:

Generally, the unthreshed grain increased by increasing both feed rate and operating forward speed, and the unthreshed grain decreased by increasing threshing drum speed, decreasing the cylinder concave clearance. Data in Table (3) show that increasing feed rate from 2000 to 3000 kg/h at drum speed of 803 rpm, increased unthreshed grain from 2.07 to 2.29% at grain moisture content 21%. The increase in the

Table (3): Effect of cylinder-concave clearance on unthreshed grain (%) at three cylinder speeds and two feed rates for rice crop (Giza 171) at moisture content 21%.

Cylinder speed, r.p.m.	Unthreshing grain, %											
	Original rotor (15 teeth)			Developed rotor (15 teeth)			Developed rotor (10 teeth)			Developed rotor (7 teeth)		
	Feed rate = 2000 kg/h at forward speed = 1.22 km/h.											
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
500	2.25	2.51	2.76	0.89	1.16	1.31	0.79	0.92	1.16	0.66	0.83	1.01
630	2.19	2.43	2.70	0.71	0.96	1.25	0.65	0.84	1.09	0.54	0.73	0.95
803	2.07	2.33	2.58	0.66	0.84	1.11	0.54	0.78	0.91	0.42	0.66	0.88
Cylinder speed, r.p.m.	Feed rate = 3000 kg/h ar forward speed = 1.91 km/h.											
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
500	2.46	2.75	2.91	1.15	1.34	1.56	0.91	1.14	1.35	0.80	1.03	1.21
630	2.41	2.66	2.85	0.94	1.17	1.38	0.82	1.06	1.23	0.72	0.95	1.16
803	2.29	2.55	2.73	0.82	1.07	1.29	0.76	0.93	1.10	0.62	0.86	1.08

* The cylinder-concave clearances of the combine were C1 (12.5/5.5), C2 (13/6) and C3 (16/7) mm front/rear for rice crop.

percentage of unthreshed grain by increasing feeding rate is attributed to the density (excessive) plants in the threshing chamber, plants leave the device without complete threshing that tends to increase unthreshed grain. Increasing drum speed from 500 to 803 rpm at feed rate of 2000 kg/h, decreased the unthreshed grain from 2.25 to 2.07% at grain moisture content 21%.

Thus, the sequence of the cylinder-concave clearance to the least values of unthreshed grain was found to be as the following order: C_1(12.5/5.5), C_2 (13/6) and C_3 (16/7) mm at grain moisture content 21%, feed rate 2000 kg/h and drum speed 803 rpm.

Also, the sequence of the four different threshing and separation drums to the least percentage value of unthreshed grain was found to be as the following order; developed vane rotors (7 teeth), developed vane rotors (7 teeth), developed vane rotors (10 teeth), developed vane rotors (15 teeth) and original vane rotors (15 teeth).

b- Grain damage:

Generally, the grain damage increased by increasing both feed rate operating forward speed and threshing drum speed, and the grain damage decreased by increasing the cylinder concave clearance. Clearance. Data in Fig. (7) show that increasing feed rate from 2000 to 3000 kg/h at drum speed of 803 rpm, increased grain damage from 2.75 to 2.98% at grain moisture content 21%. The increase in the percentage of grain damage by increasing feed rate is attributed to the excessive plants in the threshing chamber, so the capsules leave the device without complete threshing that tends to increase un-separated grain. The increase in the percentage of separation losses by increasing drum speed was attributed to the high stripping and impacting forces applied to the plants.

Thus, the sequence of the cylinder. Concave clearance to the least values of grain damage percentage was found to be as the following order: C_3 (16/7), C_2 (13/6) and C_1 (12.5/5.5) mm at grain moisture content 21%, feed rate 2000 kg/h and drum speed 803 rpm. Also, the sequence of the four different threshing and separation drums to the least percentage values of grain damage was found to be as the following order developed vane rotors (7 teeth), developed vane rotors (10 teeth), developed vane rotors (15 teeth) and original vane rotors (15 teeth).

Table (4): Effect of cylinder-concave clearance on grain damage (visible) (%) at three cylinder speeds and two feed rates for rice crop (Giza 171) at moisture content 21%).

Cylinder speed, r.p.m.	Unthreshing grain, %											
	Original rotor (15 teeth)			Developed rotor (15 teeth)			Developed rotor (10 teeth)			Developed rotor (7 teeth)		
	Feed rate = 2000 kg/h at forward speed = 1.22 km/h.											
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
500	2.31	2.07	1.89	1.13	0.93	0.76	0.95	0.81	0.68	0.73	0.61	0.55
630	2.53	2.32	2.18	1.45	1.24	0.98	1.28	1.13	0.92	0.96	0.84	0.77
803	2.75	2.56	2.39	1.74	1.56	1.31	1.59	1.44	1.36	1.13	1.07	0.91
Cylinder speed, r.p.m.	Feed rate = 3000 kg/h ar forward speed = 1.91 km/h.											
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
500	2.52	2.29	2.12	1.43	1.24	1.02	1.14	1.04	0.93	0.93	0.86	0.76
630	2.74	2.64	2.39	1.73	1.56	1.35	1.30	1.26	1.15	1.10	1.02	0.92
803	2.98	2.83	2.57	2.09	1.85	1.67	1.64	1.56	1.42	1.46	1.34	1.23

* The cylinder-concave clearances of the combine were C1 (12.5/5.5), C2 (13/6) and C3 (16/7) mm front/rear for rice crop.

c- Cleaning loses:

Generally, the cleaning losses increased by increasing both feed rate, operating forward speed and threshing drum speed, and the cleaning decreased by decreasing the cylinder concave clearance. Data in Table (5) show that increasing feed rate from 2000 to 3000 kg/h at drum speed of 803 rpm, increased cleaning losses from 0.53 to 0.55% at grain moisture content 21%.

Thus, the sequence of the cylinder-concave clearance to the least values of cleaning losses was found to be as the following order; C_1 (12.5/5.5), C_2 (13/6) and C_3 (16/7) mm at grain moisture content 21%, feed rate 2000 kg/h and drum speed 803 rpm.

Also, the sequence of the four different threshing and separation drums to the least percentage value of cleaning losses as found to be as the following order: developed vane rotors (7 teeth), developed vane rotors (10 teeth), developed vane rotors (15 teeth) and original vane rotors (15 teeth).

d- Total grain losses:

From the previous analysis and results obtained, the total grain losses including both unthreshed grain, damage and cleaning losses were illustrated in Table (6). It can be noticed that the minimum total grain losses of 1.68% will be achieved at grain moisture content 21%, drum speed of 500 rpm, feed rate of 2000 kg/h, operating forward speed of 1.22 km/h and cylinder-concave clearance (C_1) for the development vane rotors (7 teeth).

2. Effect of some operating parameters on efficiencies:

Both the threshing efficiency, grain quality an cleaning efficiency are affected by different operating parameters such as grain moisture content, feed rate, operating forward speed, threshing drum speed,…etc.

Table (5): Effect of cylinder-concave clearance on cleaning losses (%) at three cylinder speeds and two feed rates for rice crop (Giza 171) at moisture content 21%.

Cylinder speed, r.p.m.	Unthreshing grain, %											
	Original rotor (15 teeth)			Developed rotor (15 teeth)			Developed rotor (10 teeth)			Developed rotor (7 teeth)		
	Feed rate = 2000 kg/h at forward speed = 1.22 km/h.											
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
500	0.48	0.50	0.52	0.32	0.34	0.35	0.30	0.32	0.33	0.29	0.30	0.31
630	0.51	0.52	0.54	0.35	0.36	0.38	0.33	0.34	0.36	0.31	0.32	0.35
803	0.53	0.56	0.57	0.37	0.38	0.42	0.35	0.37	0.39	0.33	0.35	0.37
Cylinder speed, r.p.m.	Feed rate = 3000 kg/h ar forward speed = 1.91 km/h.											
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
500	0.50	0.52	0.54	0.34	0.37	0.38	0.33	0.35	0.36	0.30	0.32	0.34
630	0.53	0.55	0.57	0.38	0.39	0.43	0.35	0.37	0.39	0.33	0.35	0.37
803	0.55	0.57	0.59	0.41	0.43	0.45	0.38	0.40	0.41	0.37	0.36	0.38

* The cylinder-concave clearances of the combine were C1 (12.5/5.5), C2 (13/6) and C3 (16/7) mm front/rear for rice crop.

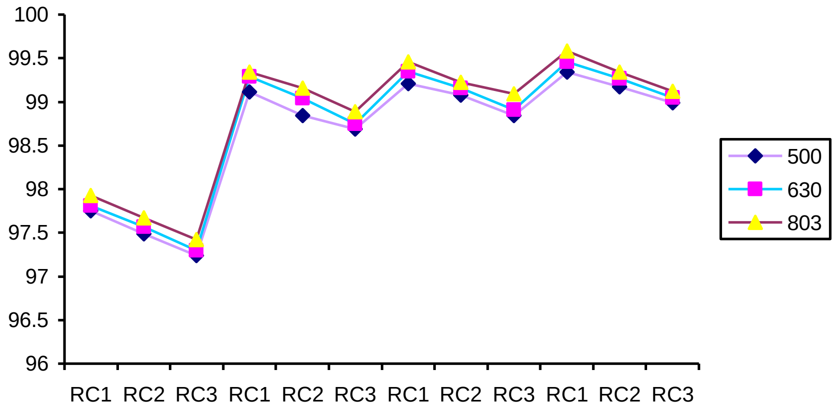
Table (6): Effect of cylinder-concave clearance on total losses (%) (Unthreshed grain, Grain damage and cleaning losses) at three cylinder speeds and two feed rates for rice crop (Giza 171) at moisture content 21%).

Cylinder speed, r.p.m.	Unthreshing grain, %											
	Original rotor (15 teeth)			Developed rotor (15 teeth)			Developed rotor (10 teeth)			Developed rotor (7 teeth)		
	Feed rate = 2000 kg/h at forward speed = 1.22 km/h.											
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
500	5.04	5.08	5.17	2.34	2.43	2.42	2.04	2.05	2.17	1.68	1.74	1.87
630	5.23	5.27	5.42	2.51	2.56	2.61	2.26	2.31	2.37	1.81	1.89	2.07
803	5.35	5.45	5.54	2.77	2.78	2.84	2.48	2.59	2.66	1.88	2.08	2.16
Cylinder speed, r.p.m.	Feed rate = 3000 kg/h ar forward speed = 1.91 km/h.											
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
500	5.48	5.56	5.57	2.92	2.95	2.96	2.38	2.53	2.64	2.03	2.21	2.31
630	5.68	5.85	5.81	3.05	3.12	3.16	2.47	2.69	2.77	2.15	2.32	2.45
803	5.82	5.95	5.89	3.32	3.35	3.41	2.78	2.89	2.93	2.43	2.56	2.69

* The cylinder-concave clearances of the combine were C1 (12.5/5.5), C2 (13/6) and C3 (16/7) mm front/rear for rice crop.

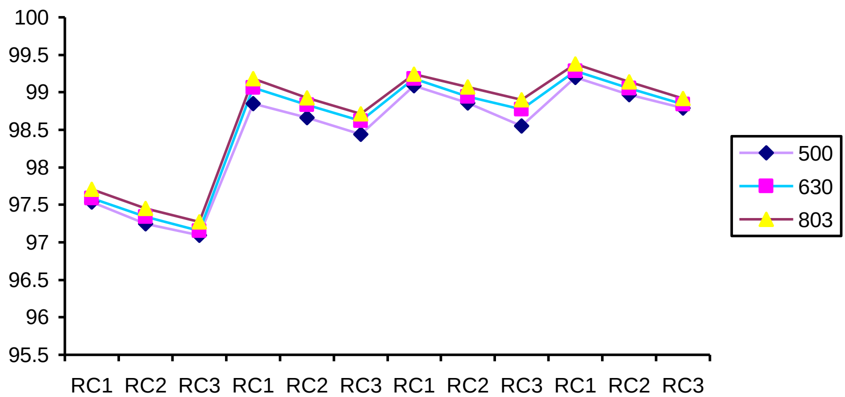
Generally, the threshing efficiency increased by decreasing the feed rate and operating forward speed, and threshing efficiency decreased by decreasing threshing drum speed, increasing cylinder-concave clearance. Fig. (6) show that increasing the threshing drum speed from 500 to 803 rpm at feed rate of 2000 kg/h and grain moisture content 21%, increased the threshing efficiency from 98.34 to 99.58% for the developed rotor (7 teeth). On the other side, increasing the feed rate from 2000 to 3000 kg/h at constant drum speed of 500 rpm at grain 99.34 to 99.20% for the developed rotor (7 teeth). The grain quality increased by decreasing feed rate, operating forward speed and threshing drum speed, and the grain quality decreased by decreasing cylinder-concave clearance. Fig. (7) show that increasing the threshing drum speed from 500 to 803 rpm at feed rate of 2000 kg/h and grain moisture content 21%, decreased grain quality from 99.27 to 98.87%, on the other side, increasing the feed rate from 2000 to 3000 kg/h at constant drum speed of 500 rpm, grain moisture content 21%, the grain quality decreased from 99.27 to 99.07% for the developed rotor (7 teeth).

The cleaning efficiency increased by decreasing feed rate, operating forward speed and threshing drum speed, and the cleaning efficiency decreased by increasing the cylinder-concave clearance. Fig. (8) show that increasing the threshing drum speed from 500 to 800 rpm at feed rate of 2000 kg/h, grain moisture content 21%, decreased cleaning efficiency from 99.70 to 99.65%. On the other side increasing the feed rate from 2000 to 3000 kg/h at constant drum speed of 500 rpm, grain moisture content 21%, the cleaning efficiency decreased from 99.71 to 99.70% for the developed rotor (7 teeth).



Cylinder speed, r.p.m.

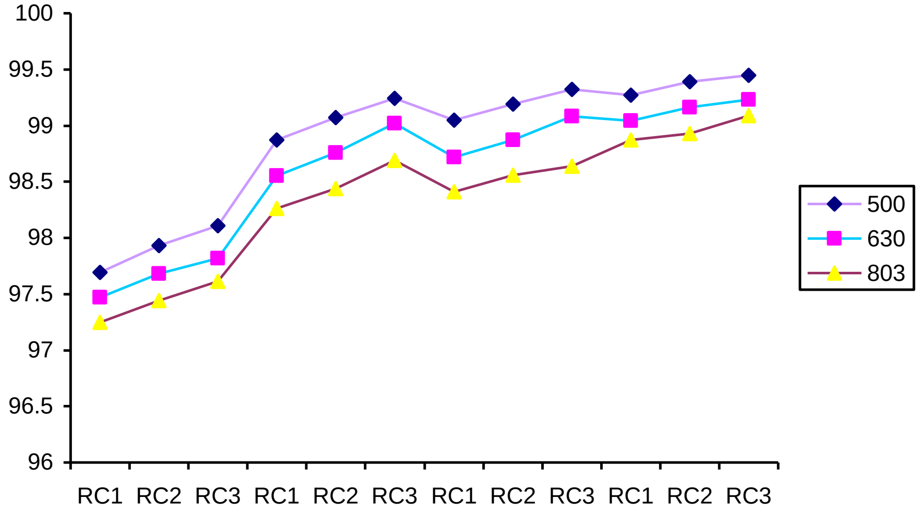
(A) At feed rate 2000 kg/h.



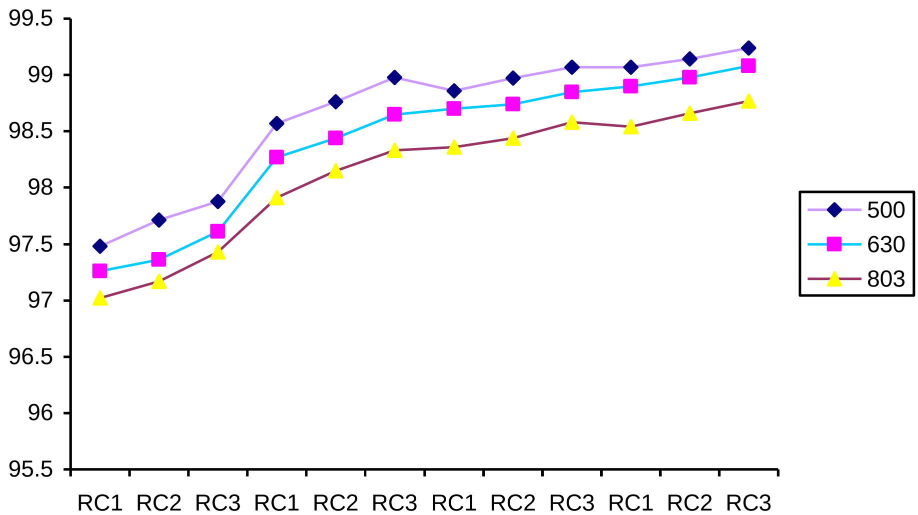
Cylinder speed, r.p.m.

(**B**) At feed rate 3000 kg/h.

Fig. (6): Effect of cylinder-concave clearance on threshing efficiency (%) at three cylinder speeds and two feed rates for rice crop (Giza 171) at moisture content 21%

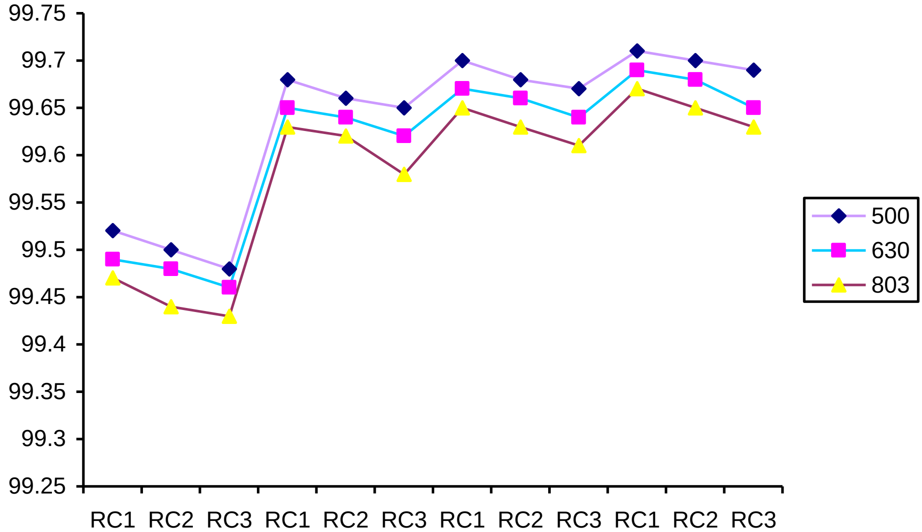


Cylinder speed, r.p.m.
(A) At feed rate 2000 kg/h.

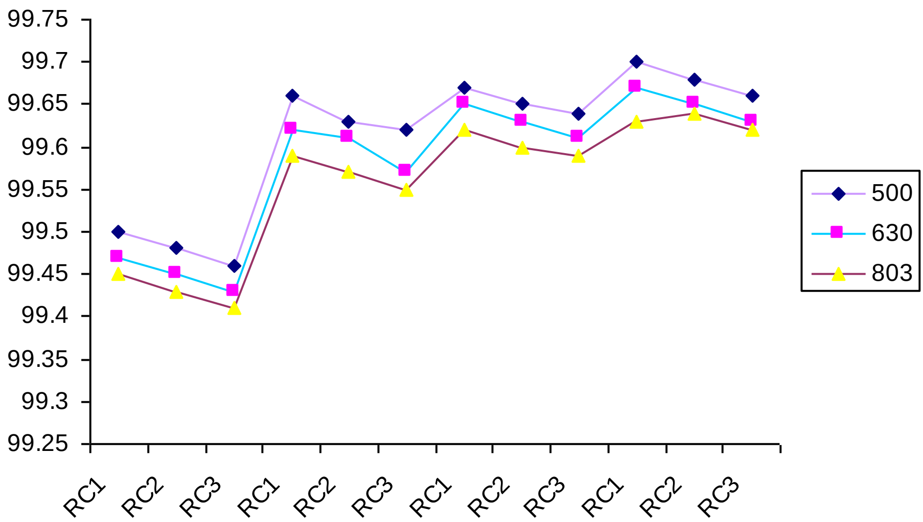


Cylinder speed, r.p.m.
(**B**) At feed rate 3000 kg/h.

Fig. (7): Effect of cylinder-concave clearance on grain quality (%) at three cylinder speeds and two feed rates for rice crop (Giza 171) at moisture content 21%



Cylinder speed, r.p.m.
(A) At feed rate 2000 kg/h.



Cylinder speed, r.p.m.
(**B**) At feed rate 3000 kg/h.

Fig. (8): Effect of cylinder-concave clearance on cleaning efficiency (%) at three cylinder speeds and two feed rates for rice crop (Giza 171) at moisture content 21%

3- Effect of operating parameters on power and energy requirements:

From the results, the cylinder-concave clearance was adjusted on C_1 (12.5/5.5) mm, values of the actual field capacity, theoretical field capacity and the field efficiency for the different types of threshing and separation drums for the combine at grain moisture content 21% are found as shown in Tables (7) through (10).

According to Table (7) through (1) it is clear that the highest values of the actual field capacity was found to be as the developed vane rotors (7 teeth), it compare both the developed vane rotors (10 teeth), the developed vine rotors (15 teeth) and the original vane rotors (15 teeth). Also, from the Table (7) through (10) it is clear that the highest values of the field efficiency was found to be as the developed vine rotors (7 teeth), it compare both the developed vine rotors (10 teeth), the developed vine rotors (15 teeth) and the original vane rotors (15 teeth).

Tables (7) through (10) show the relation between drum speed and feed rate with power and energy requirements. Increasing feed rate from 2000 to 3000 kg/h at drum speed of 500 rpm and grain moisture content of 21%, the power increased from 14.761 + 020.698 kw, and the energy requirement increased from 30.186 to 32.140 kw.h/fed. for the developed vine rotors (7 teeth). Increasing energy required by increasing feed rate is attributed to the excessive plants in the threshing chamber which represent more loads on the drum, resulting in more fuel consumption and energy. On the other side, increasing the drum speed from 500 to 803 rpm at constant feed rate of 2000 kg/h and grain moisture content of 21%, increased the energy required from 30.186 to 32.147 kw.h/fed. The sequence of the four threshing and separation drums to the least values of the required power and energy are found to be as the following order: developed vine rotors (7 teeth), developed vine rotors (10 teeth), developed vine rotors (15 teeth) and original vine rotors (15 teeth).

Table (7): Effect of operating forward speed and cylinder speeds for combine (class crop tiger) with the original vane rotors (15 teeth) on the actual field capacity, field efficiency, power required and energy requirements.

Cylinder speed, r.p.m.	Forward operating speed, km/h	Theoretical F.C., fed./h	Actual field capacity, fed./h	The field efficiency, %	Measured fuel consumption, L/h	Power required, kw	Energy requirements	
							kw.h/fed.	MJ/fed.
500	1.22	0.610	0.429	70.33	6.90	22.142	51.613	185.807
	1.91	0.955	0.531	55.60	8.70	27.918	52.576	189.274
630	1.22	0.610	0.440	72.13	7.20	23.105	52.511	189.040
	1.91	0.955	0.548	57.38	9.10	29.202	53.288	191.837
803	1.22	0.610	0.453	74.26	7.50	24.067	53.128	191.261
	1.91	0.955	0.571	59.79	9.70	31.127	54.513	196.247

* Field dimension for 4.1 feddan (length 383 m x width 44.85 m).

** The dimension for the plot were 383 m in length and 7.48 m in width.

*** Cylinder-concave, clearance C1 (12.5/5.5 mm).

**** The working width for combine (class crop tiger) = 2.10 m.

Table (8): Effect of operating forward speeds and cylinder speeds for combine (class crop tiger) with the developed vane rotors (15 teeth) on the actual field capacity, field efficiency, power required and energy requirements..

Cylinder speed, r.p.m.	Forward operating speed, km/h	Theoretical F.C., fed./h	Actual field capacity, fed./h	The field efficiency, %	Measured fuel consumption, L/h	Power required, kw	Energy requirements	
							kw.h/fed.	MJ/fed.
500	1.22	0.610	0.460	75.41	5.90	18.933	41.159	148.172
	1.91	0.955	0.577	60.42	7.80	25.030	43.379	156.164
630	1.22	0.610	0.468	76.72	6.20	19.896	42.513	153.047
	1.91	0.955	0.597	62.51	8.20	26.314	44.077	158.677
803	1.22	0.610	0.481	78.85	6.50	20.858	43.364	156.110
	1.91	0.955	0.620	64.92	8.70	27.918	45.029	162.104

* Field dimension for 4.1 feddan (length 383 m x width 44.85 m).

** The dimension for the plot were 383 m in length and 7.48 m in width.

*** Cylinder-concave, clearance C1 (12.5/5.5 mm).

**** The working width for combine (class crop tiger) = 2.10 m.

Table (9): Effect of operating forward speed and cylinder speeds for combine (class crop tiger) with the developed vane rotors (10 teeth) on the actual field capacity, field efficiency, power required and energy requirements.

Cylinder speed, r.p.m.	Forward operating speed, km/h	Theoretical F.C., fed./h	Actual field capacity, fed./h	The field efficiency, %	Measured fuel consumption, L/h	Power required, kw	Energy requirements	
							kw.h/fed.	MJ/fed.
500	1.22	0.610	0.473	77.54	5.10	16.366	34.600	124.560
	1.91	0.955	0.599	62.72	7.00	22.463	37.501	135.004
630	1.22	0.610	0.842	79.02	5.40	17.329	35.952	129.427
	1.91	0.955	0.620	64.92	7.30	23.426	37.784	136.022
803	1.22	0.610	0.492	80.65	5.70	18.291	37.177	133.837
	1.91	0.955	0.648	67.85	7.80	25.030	38.626	139.054

* Field dimension for 4.1 feddan (length 383 m x width 44.85 m).
** The dimension for the plot were 383 m in length and 7.48 m in width.
*** Cylinder-concave, clearance C1 (12.5/5.5 mm).
**** The working width for combine (class crop tiger) = 2.10 m.

Table (10): Effect of operating forward speed and cylinder speeds for combine (class crop tiger) with the developed vane rotors (7 teeth) on the actual field capacity, field efficiency, power required and energy requirements.

Cylinder speed, r.p.m.	Forward operating speed, km/h	Theoretical F.C., fed./h	Actual field capacity, fed./h	The field efficiency, %	Measured fuel consumption, L/h	Power required, kw	Energy requirements	
							kw.h/fed.	MJ/fed.
500	1.22	0.610	0.489	80.16	4.60	14.761	30.186	108.670
	1.91	0.955	0.644	67.43	6.45	20.698	32.140	115.704
630	1.22	0.610	0.525	86.06	5.20	16.687	31.785	114.426
	1.91	0.955	0.688	72.04	7.20	23.105	33.583	120.899
803	1.22	0.610	0.564	92.46	5.65	18.131	32.147	115.729
	1.91	0.955	0.710	78.64	7.60	24.388	34.349	123.656

* Field dimension for 4.1 feddan (length 383 m x width 44.85 m).

** The dimension for the plot were 383 m in length and 7.48 m in width.

*** Cylinder-concave, clearance C1 (12.5/5.5 mm).

**** The working width for combine (class crop tiger) = 2.10 m.

4. Effect of operating parameters on criterion cost:

The criterion cost is considered the main indicator, which judges the evaluation of the four threshing and separation drums. Results in Table (11) shows that, the total costs per unit area are 314.75, 270.25, 240.50 and 223.50 LE/fed. for the original vane rotors (15 teeth), developed vane rotors (15 teeth), developed vane rotors (10 teeth) and developed vane rotors (7 teeth). The sequence of the four threshing and separation drums to the least values of the cost per unit area was found to be as the following order; developed vane rotors (7 teeth), developed vane rotors (10 teeth), developed vane rotors (15 teeth) and original vane rotors (15 teeth). Also, results in Table (11) it was remarked that, better results were reached under operating conditions were drum speed of 500 rpm, fed rate of 200 kg/h, operating forward speed of 1.22 km/h, cylinder-concave clearance (C_1, 12.5/5.5 mm), energy required of 30.186 kw.h/fed., operating costs of 223.50 LE./fed., total grain losses of 1.68% and threshing efficiency of 99.34%.

Table (11): Cost analysis for the different types of threshing and separation drums for the combine harvester (class crop tiger).

Implements	Fixed costs, LE/h	Variable costs/ LE/h	Manufacture costs, LE/h	Total costs, LE/h	Actual field capacity, fed./h	Total costs, LE/fed.
The original vane rotors (15 teeth)	29.40	99.00	6.64	135.04	0.429	314.75
The developed vane rotors (15 teeth)	29.40	88.26	6.64	124.30	0.460	270.2
The developed vane rotors (10 teeth)	29.40	79.68	4.64	113.72	0.473	240.50
The developed vane rotors (7 teeth)	29.40	76.45	3.44	109.29	0.489	223.50

* Field dimension for 4.1 feddan (length 383 m x width 44.85 m).
** The dimension for the plot were 383 m in length and 7.48 m in width.
*** Cylinder-concave, clearance C1 (12.5/5.5 mm).
**** The working width for combine (class crop tiger) = 2.10 m.

CONCLUSION

The obtained results from the present investigation could be summarized of follow:

1- The unthreshed grain increased by increasing both feed rate and operating forward speed, and the unthreshed grain decreased by increasing threshing drum speed, decreasing the cylinder-concave clearance.
2- The grain damage increased by increasing both feed rate, operating forward speed and threshing drum speed and it decreased by increasing the cylinder-concave clearance.
3- The cleaning losses increased by increasing both feed rate, operating forward speed and threshing drum speed and it decreased by deceasing the cylinder-concave clearance.
4- The minimum total grain losses of 1.68% will be achieved at grain moisture content 21%, threshing drum speed of 500 rpm (17.0 m/s), feed rate of 2000 kg/h, operating forward speed of 1.22 km/h and cylinder-concave clearance (C1, 12.5/5.5m) for the development vane rotors (7 teeth).
5- The threshing efficiency increased by decreasing the feed rate and operating forward speed, and it decreased by decreasing the threshing drum speed, increasing the cylinder-concave clearance.
6- The grain quality increased by decreasing the feed rate, operating, forward speed and threshing drum speed, and it decreased by decreasing the cylinder-concave clearance.
7- The cleaning efficiency increased by decreasing the feed rate, operating forward speed and threshing forward speed, and it decreased by increasing the cylinder-concave clearance.
8- The highest values of the actual field capacity was found to be as the developed vane rotors (7 teeth), it compare both the developed vane rotors (10 teeth), developed vane rotors (15 teeth) and original vane rotors (15 teeth).
9- The least values of the required energy was found to be as the developed vine rotors (7 teeth), it compare both the developed vane rotors (10 teeth), developed vine rotors (15 teeth) and original vane rotors (15 teeth).
10- The least values of the operating costs was found to be as the

developed rotor (7 teeth), it compare both the developed rotor (10 teeth), the developed rotor (15 teeth) and the original rotor (15 teeth).

11- The better results were reached under operating conditions were threshing drum speed of 500 rpm (17.0 m/s), feed rate of 2000 kg/h, operating forward speed 1.22 km/h, cylinder-concave clearance of C_1 (12.5/5.5 m), energy required of 30.186 kw.h/fed; operating costs of 223.50 LE/fed., total grain losses of 1.68% and threshing efficiency of 99.34%, separation efficiency of 99.27% and clearing efficiency of 99.71% for the develop rotor (7 teeth).

12- The total operating costs per unit area are 314.75, 270.25, 240.5 and 223.50 LE.fed. for the original vane rotors (15 teeth), developed vane rotors (15 teeth), developed vane rotors (10 teeth) and developed vane rotors (7 teeth).

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الملخص العربى

تطوير جهاز الدراس فى آلة حصاد جامعة لتحسين كفاءة أدائها فى دراس الأرز

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استخدم فى هذه الدراسة كومباين متوسط الحجم (الكومباين الألمانى Crop Tiger) والذى يمتاز بأنه متوسط الوزن وعرض تشغيله ٢.١٠ متر ومحمول على عجلات كاوتش وهو مصمم للعمل أساساً فى حصاد محصول القمح والأرز ومحاصيل أخرى. أوضحت تقارير مشغلى الآلة كروب تيجر أنه توجد صعوبات فى إمكانية التشغيل المستمر للآلة لعدم سهولة الحركة الميكانيكية فى جزء الدراس والفصل مما يعيق عملية التشغيل والذى يتسبب فى نقص إنتاجية الآلة وزيادة الفقد فى الحبوب ولذلك تم تطوير الدوار المسئول عن السريان المحورى للمحصول لزيادة كفاءة أداءه. وتمثل التطوير فى تصنيع دوار Vane rotors جديد بتصميم جديد لريش الفصل والسريان المحورى وعمل دراسة مقارنة على الدارفيل المطورة والدرفيل الأصلى وذلك على محصول الأرز (صنف جيزة ١٧١).

وقد أجريت التجارب فى حقول الأرز فى مساحة ٤.١٠ فدان بقرية أحمد رامى – وزارة الزراعة – استصلاح الأراضى – مشروعها مبارك القومى بإنتاج ابارود – محافظة البحيرة ع ام ٢٠٠٤، ٢٠٠٥.

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مواصفات أسطوانة الدراس والفصل قبل وبعد التطوير:

١. تم تغيير ريش الفصل الأربعة المستقيمة ومتوازية مع محور الأسطوانة حيث كانت تعيق عملية سحب قش المحصول بعد دراسة فى اتجاه فتحة الطرد وذلك بأربعة ريش شبة حلزونية ذات أربعة مسارات مما يكون له ا لأثر الأكبر فى عملية السحب مع ثبات مروحة الطرد ذات حافة مستقيمة (غير مسننة) حتى يقلل من فرصة ركن قش المحصول فى هذا الحيز لحدوث الدوران.

٢. طول أسطوانة الدراس والفصل ١٨٠سم ومقسمة إلى ثلاثة أقسام، الأول منطقة الدراس بطول ٥٧.٥سم وتم استخدام الدرفيل ذو الأسنان Spike teeth drum فى دراس محصول الأرز صنف جيزة (١٧١) والثانى منطقة الفصل بطول ٩٠.٥سم وتم تغيير الطول إلى ١١٠.٥سم (بزيادة ١٠سم) وذلك بتغيير طول رمش الفصل لأن ذلكيعطى فرصة أكبر لفصل القش عن باقى الحبوب وسرعة التخلص من مخلفات الفصل والثالث منطقة الطرد بطول ٣٢.٠سم وثم تقليل طول منطقة الطرد إلى ٢٢سم (بنقص ١٠سم) لاستغلال الفرق فى الطول فى منطقة الفصل دون التاثير على معدل الطرد لثبوت مساحة فتحة الطرد وهى (٣٠×٤٠سم).

٣. زيادة سمك ريش الفصل فى الأسطوانة الأصلية من ٣.٥ إلى ٥مم وذلك لإعطاء الدرفيل مكانة وقوة، وعدم تعرضه للتلف بسبب ضعف الخامات المصنعة ونتيجة دخول الحجارة فى بعض الأحيان مع المحصول أو نتيجة فك أحد عوارض الدراس أثناء التشغيل.

٤. ثم استخدام نوع من المعدن (صلب ٦٠) لأنه عالى الكربون مع توفره بالأسواق ومعالجته قبل التشغيل لتصنيع الريش الددوارة المستخدمة فى عملية الفصل.

تم استخدام ثلاث سرعات لأسطوانة الدراس ٥٠٠، ٦٣٠، ٨٠٣ لفة/دقيقة وثلاثة مراحل للخلوص بين الصدر والدرفيل ١٢.٥/٥.٥، ١٣/٦، ١٦/٧مم ومعدلان للتغذية ٢٠٠٠، ٣٠٠٠ كجم/ساعة.

تم تقييم أداء الدرافيل المطورة والدرفيل الأصلى من خلال القياسات التالية:

- نسبة فواقد الحبوب (فواقد درفيل الدراس، فواقد الفصل، فواقد النظافة والفواقد الكلية).
- كفاءة الآلة (كفاءة الدراس، كفاءة الفصل، كفاءة التنظيف).
- الطاقة المطلوبة لعملية الدراس.
- تكاليف التشغيل لعملية الدراس.

وأوضحت النتائج ما يلى:

١- فاقد الحبوب الغير مدروسة يزداد بزيادة كل من معدل التغذية وسرعة التشغيل الأمامية ويقل فاقد الحبوب الغير مدروسة بزيادة سرعة درفيل الدراس وإنخفاض الخلوص بين الدرفيل والصدر.

٢- فاقد الحبوب المدروسة يزداد بزيادة كل من معدل التغذية وسرعة التشغيل الأمامية وسرعة درفيل الدراس ويقل فاقد الحبوب المدروسة بزيادة الخلوص ما بين الدرفيل والصدر.

٣- فاقد التنظيف يزداد بزيادة كل من معدل التغذية وسرعة التشغيل الأمامية وسرعة درفيل الدراس ويقل فاقد التنظيف بانخفاض الخلوص بين الدرفيل والصدر.

٤- الفواقد الكلية للحبوب تقل بانخفاض كل من معدل التغذية وسرعة التشغيل الأمامية وسرعة

درفيل الدراس والخلوص بين الدرفيل والصدر. وجد أن أقل قيمة للفواقد الكلية للحبوب وهى ١.٦٨% عند رطوبة نسبية للحبوب ٢١%، سرعة درفيل الدراس ٥٠٠ لفة/دقيقة ومعدل تغذية ٢٠٠٠ كجم/ساعة وسرعة تشغيل أمامية ١.٢٢ كم/ساعة والخلوص ٥.٥/١٢.٥ مم بين الدرفيل والصدر وذلك عند الدرفيل المطور (٧ سنة).

٥- كفاءة الدراس تزداد بانخفاض كل من معدل التغذية وسرعة التشغيل الأمامية وتقل كفاءة الدراس بانخفاض سرعة درفيل الدراس وزيادة الخلوص بين الدرفيل والصدر.

٦- كفاءة الفصل تزداد ب انخفاض كل من معدل التغذية وسرعة التشغيل الأمامية وسرعة درفيل الدراس وتقل كفاءة الفصل بانخفاض الخلوص بين الدرفيل والصدر.

٧- كفاءة التنظيف تزداد بانخفاض كل من معدل التغذية وسرعة التشغيل الأمامية وسرعة درفيل الدراس وتقل كفاءة التنظيف بزيادة الخلوص بين الدرفيل والصدر.

٨- أعلى قيم للانتاجية الفعلية عند معدل تغذية ٢٠٠٠ كجم/ساعة وسرعة تشغيل أمامية ١.٢٢ كم/ساعة ورطوبة نسبية للحبب ١% وسرعة درفيل الدراس ٥٠٠ لفة/دقيقة والخلوص ٥.٥/١٢.٥ مم بين الدرفيل والصدر كانت للدرفيل المطور ٧ سنة (٠.٤٨٩ فدان/ساعة) يليها الدرفيل المطور ١٠ سنة (٠.٤٧٣ فدان/ساعة) يليها الفدان المطوره ١ سنة (٠.٤٦٠ فدان/ساعة) وأخيراً الدرفيل الأصلى (٠.٤٢٩ فدان/ساعة).

٩- أقل قيم للطاقة المطلوبة للدراس عند معدل تغذية ٢٠٠٠ كجم/ساعة وسرعة تشغيل أمامية ١.٢٢كم/ساعة ورطوبة نسبية للحبوب ٢١% وسرعة درفيل الدراس ٥٠٠ لفة/دقيقة والخلوص ٥.٥/١٢.٥ مم بين الدرفيل والصدر كانت للدرفيل المطور ٧ سنة (٣٠.١٨٦ ك وات.ساعة/فدان) يليها الدرفيل المطور ١٠ سنة (٣٤.٦٠٠ ك وات.ساعة/فدان) يليها الفدان المطور ١٥ سنة (٤١.١٥٩ ك وات. ساعة/فدان) وأخيراً الدرفيل الأصلى ١٥ سنة (٥١.٦١٣ ك وات.ساعة/فدان).

١٠- أقل قيم لتكاليف التشغيل عند معدل تغذية ٢٠٠٠كجم/ساعة وسرعة تشغيل أمامية ١.٢٢كم/ساعة ورطوبة نسبية للحبوب ٢١% وسرعة درفيل الدراس ٥٠٠ لفة/دقيقة والخلوص ٥.٥/١٢.٥ مم بين الدرفيل والصدر كانت للدرفيل المطور ٧ سنة (٢٢٣.٥٠ جنيه/فدان) وأخيراً الدرفيل الأصلى (٣١٤.٧٥ جنيه/فدان).

١١- أفضل نتائج تشغيل كانت عند سرعة درفيل ٥٠٠ لفة/دقيقة (١٧م/ث) ومعدل تلقيم ٢٠٠٠ كجم/ساعة وسرعة تشغيل أمية ١.٢٢كم/ساعة الخلوص بين درفيل الدراس والصدر ٥.٥/١٢.٥ مم وأقل طاقة مطلوبة ٣٠.١٨٦ ك وات. ساعة/فدان وأقل تكاليف تشغيل ٢٢٣.٥٠ جنيه/فدان وأقل فواقد للحبوب ١.٦٨ وكفاءة الدراس ٩٩.٣٤% وكفاءة الفصل ٩٩.٢٧% وكفاءة التنظيف ٩٩.٧١% كانت للدرفيل المطور ٧ سنة بمقارنة بباقى الدرافيل المطورة والدرفيل الأصلى.

ومن النتائج المتحصل عليها يمكن التوصية بما يلى:

١- استخدام الدرافيل المطورة ٧ سنة، ١٠ سنة، ١٥ سنة بدلاًمن الدرفيل الأصلى (١٥ سنة) لجهاز الدراس والفصل الآلة الحصاد الجامعة عند دراس الأرز.

٢- يفضل استخدام الدرفيل المطور ٧ سنة بصفة خاصة لجهاز الدراس والفصل لتفوقه فى كل معايير التقييم بمقارنة باقى الدرافيل المطورة والدرفيل الأصلى.